metal finishing

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING
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Vol. 6 No. 72 (New series) DECEMBER, 1960

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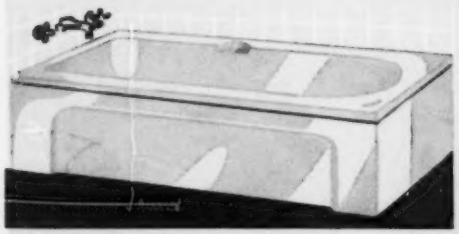

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Only superlatives will describe the Ecco 40. It's the finest spray-gun you can buy! Suitable for applying any kind of paint or lacquer, it gives perfect atomization whatever the flow or fan width. Pressure loss is negligible and the high velocity and large air and fluid ducts give the gun an unequalled capacity—25 to 30% greater than any other spray gun on the market.

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Leaflets and literature describing the Ecco 40 spray gun and the Atlas Copco range of paint spraying equipment are readily available on request from your local Atlas Copco company or agent or from the address below.

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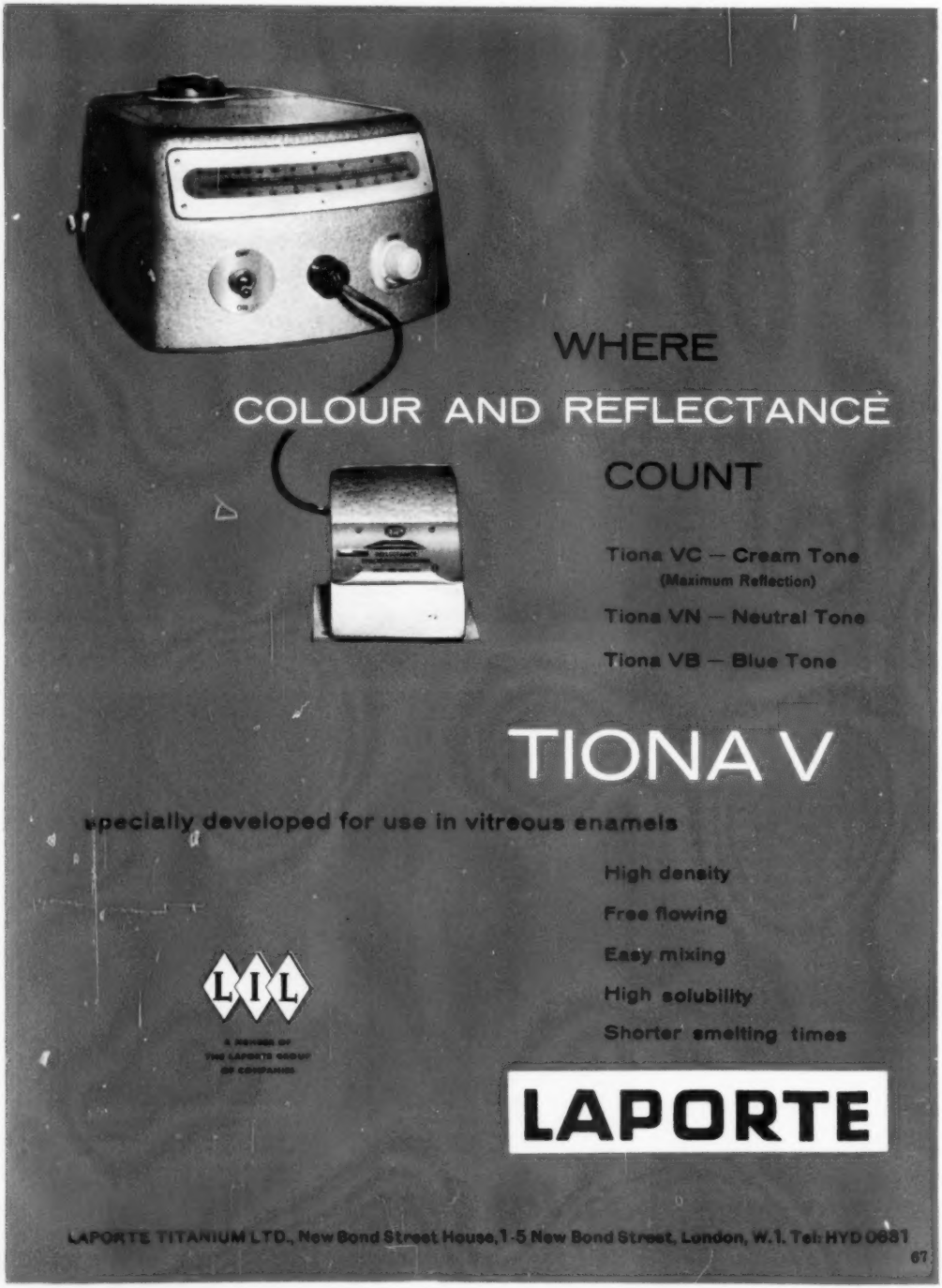
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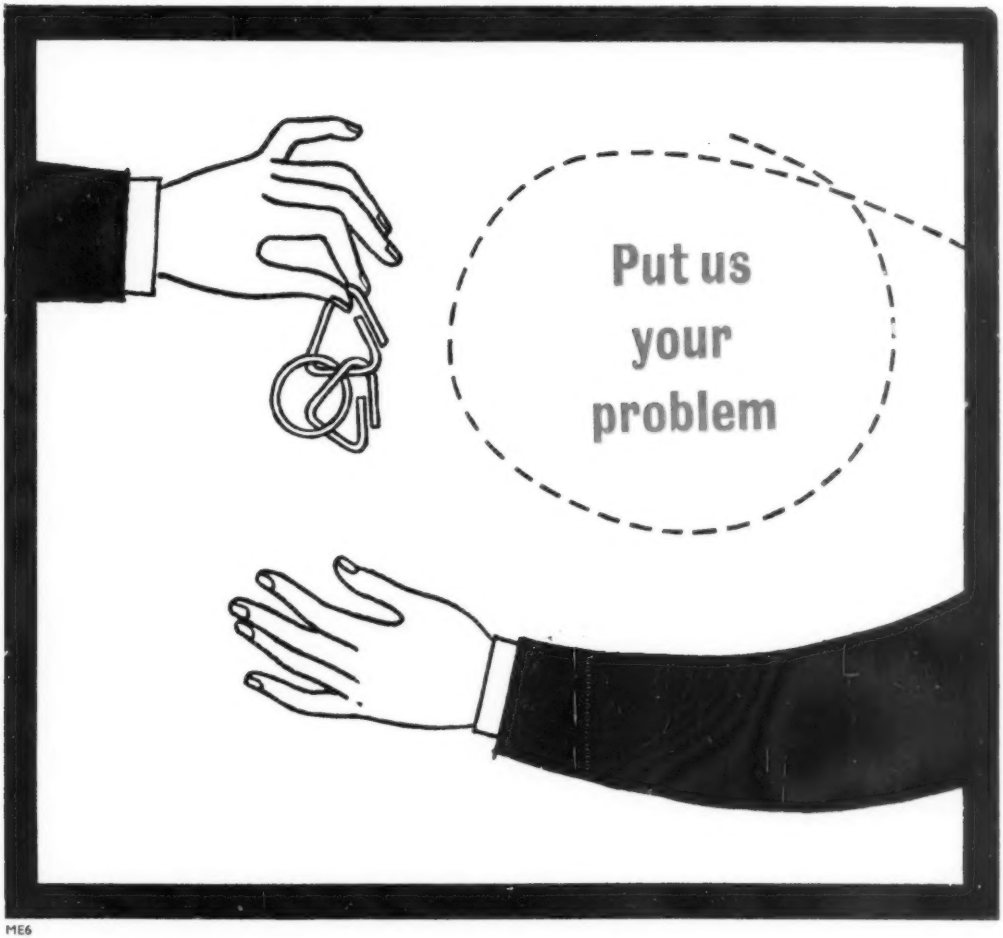

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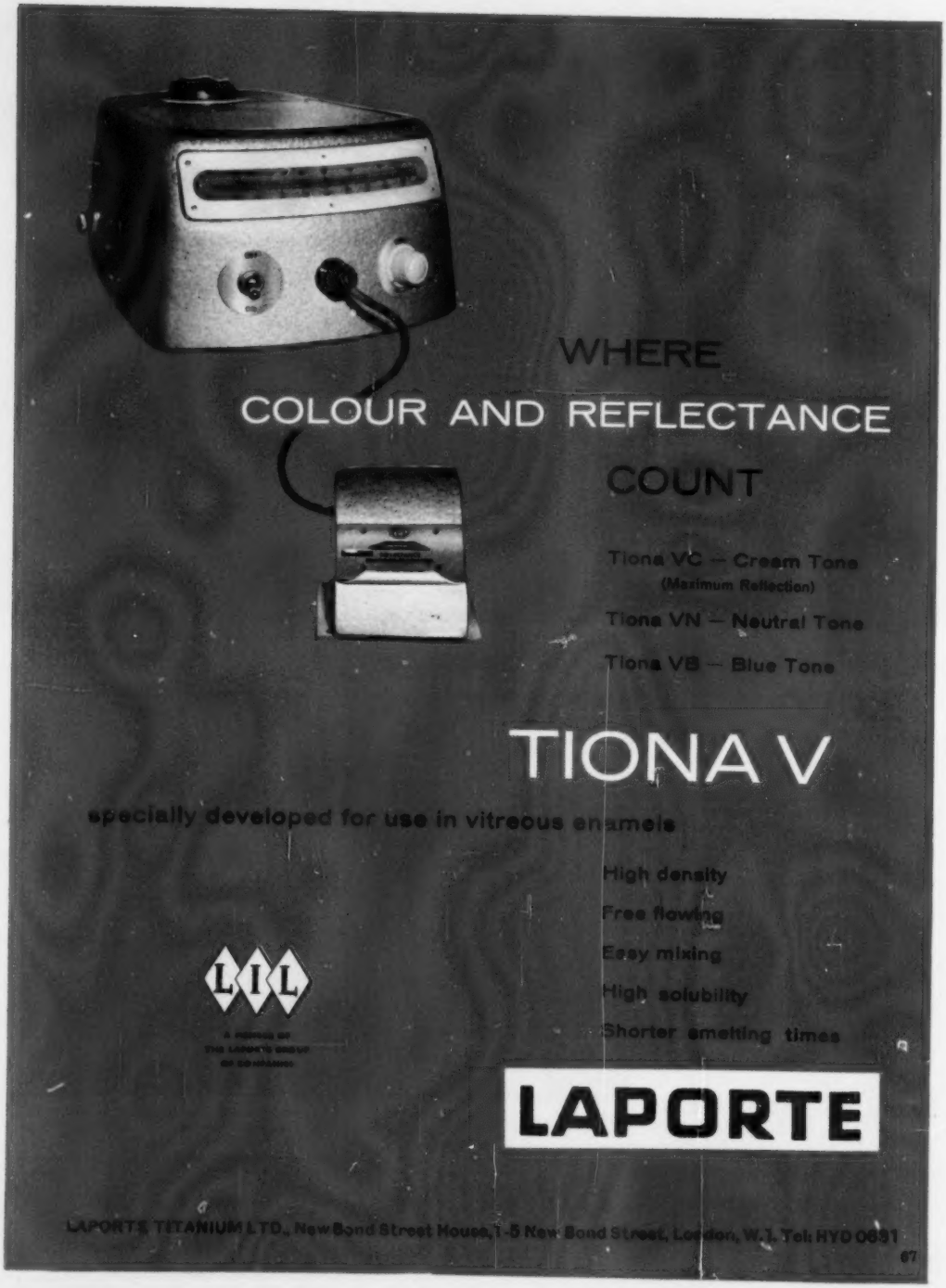
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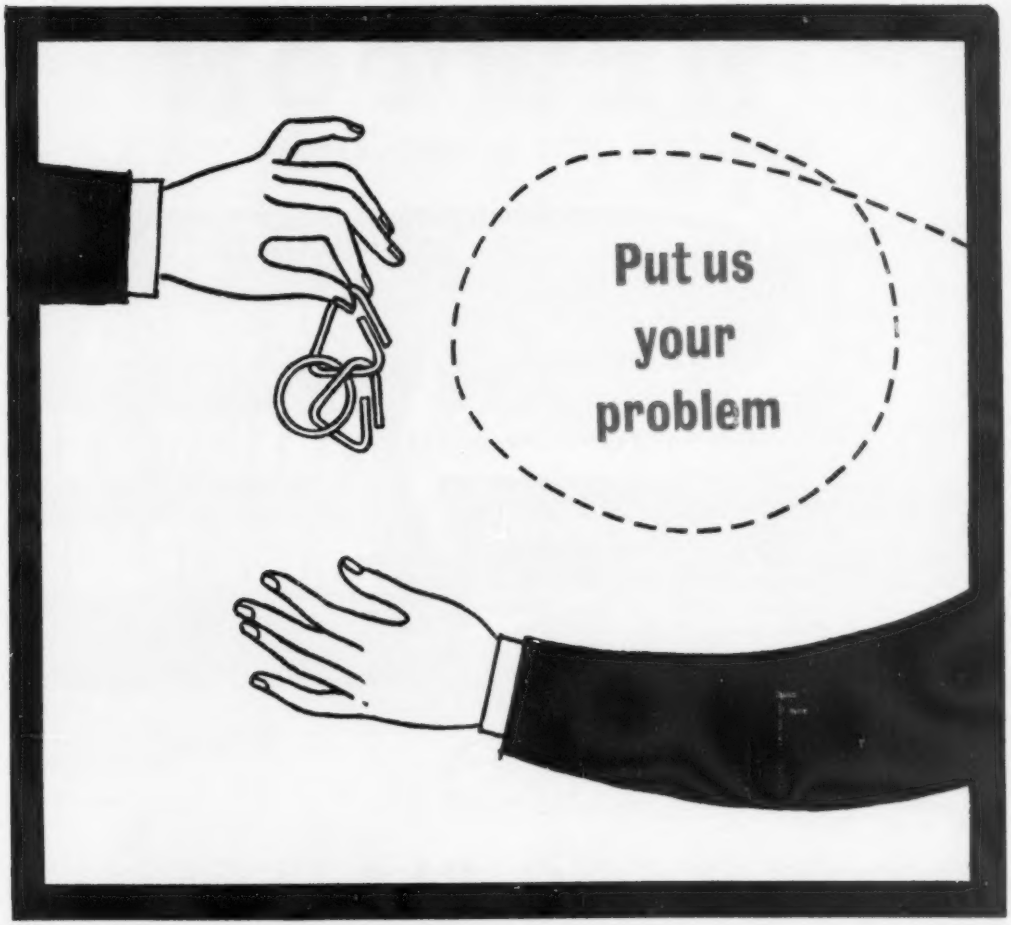

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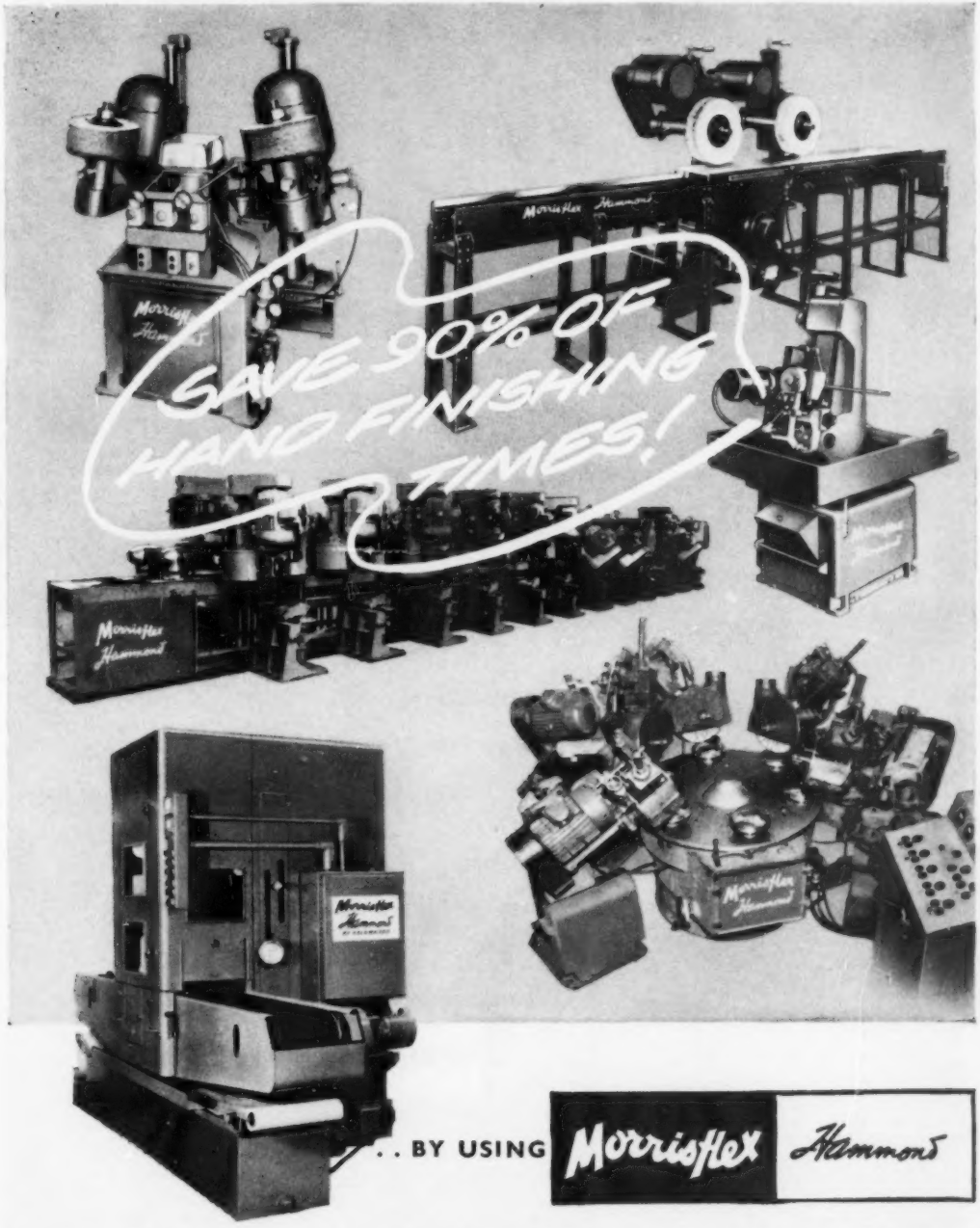

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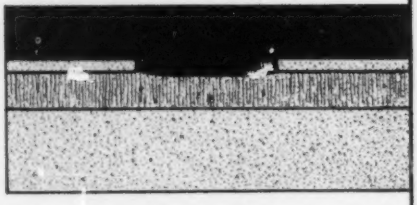

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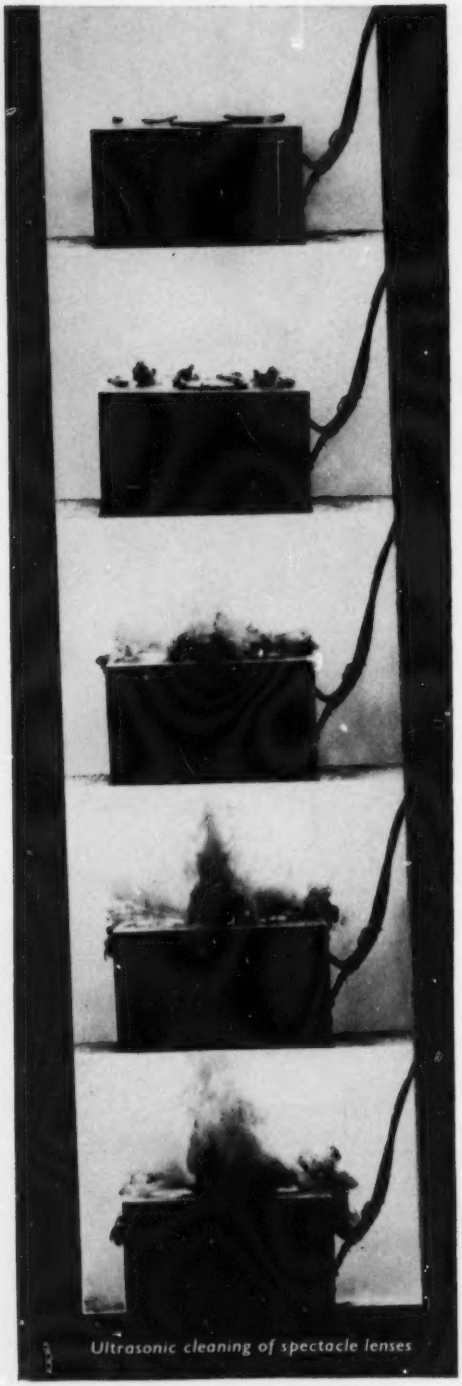

Ultrasonic cleaning of spectacle lenses

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cleans ultra-efficiently

HOW?

By introducing high frequency pressure waves in liquid cleaning media (alkaline or solvents), causing momentary tiny vacua, called cavitations. The effect is a mechanical scrubbing action on surfaces to be cleaned, removing all oily or solid contaminations like dirt, swarf or grease. The pressure waves are created by immersed nickel transducers, which oscillate at a frequency of 22 kilocycles, the source of which is a valve generator converting the mains current to high frequency current.

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Ultrasonic cleaning is the most effective method of cleaning articles which are difficult to clean by ordinary methods. In particular, parts which are contaminated with solid soil, such as pieces of polishing cloth or polishing paste, swarf in fine holes, enclosed angles, ridges, ledges, hollows; parts with dirt deposits of long standing; parts having residues of hardening compound, etc.

WHERE?

Ultrasonic cleaning can be applied in any kind of conventional cleaning installation, such as alkaline cleaning tanks, Tri-degreasers, etc., by simply immersing the nickel transducers in the cleaning liquid. Special equipment entirely adapted to particular applications of Ultrasonic cleaning, either hand operated or fully automatic, can be supplied.

FURTHER QUESTIONS . . . concerning Ultrasonic Cleaning, its capabilities and characteristics, are answered in our special leaflet. Please write for a copy.

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Barrelling and Vibrafinishing for metal and plastics to deburr, descale, deflash, radius, surface blend, polish or lustre.	Electropolishing.
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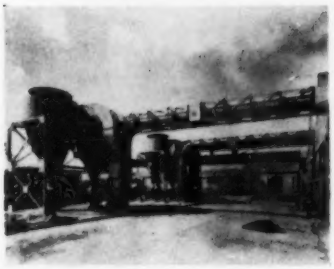
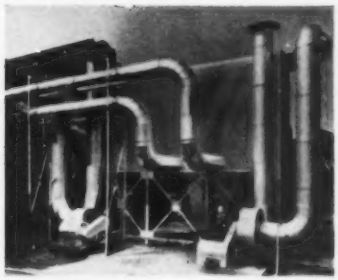
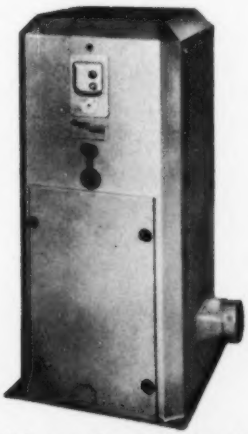
DUST AND FUME EXTRACTION

GRIFFITHS PRECIPITATION PLANT



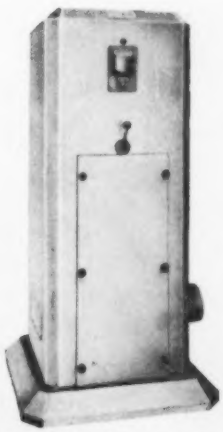


The choice of dust extraction equipment depends on a number of factors—size and nature of dust involved, the value of this dust as a by-product, the degree of exhausting and separation efficiency required. Our intensive research into the control of industrial dust enables us to offer advice on this subject for large or small installations, according to **your** requirements.



Unit type Dust Collectors to provide efficient dust extraction and separation at its source.

Wet or dry dust extraction systems for metals or wood-working operations, and for exhausting chemical fumes and moist gases we specialise in glass fibre or P.V.C. fabrications, which have a high chemical resistance quality.



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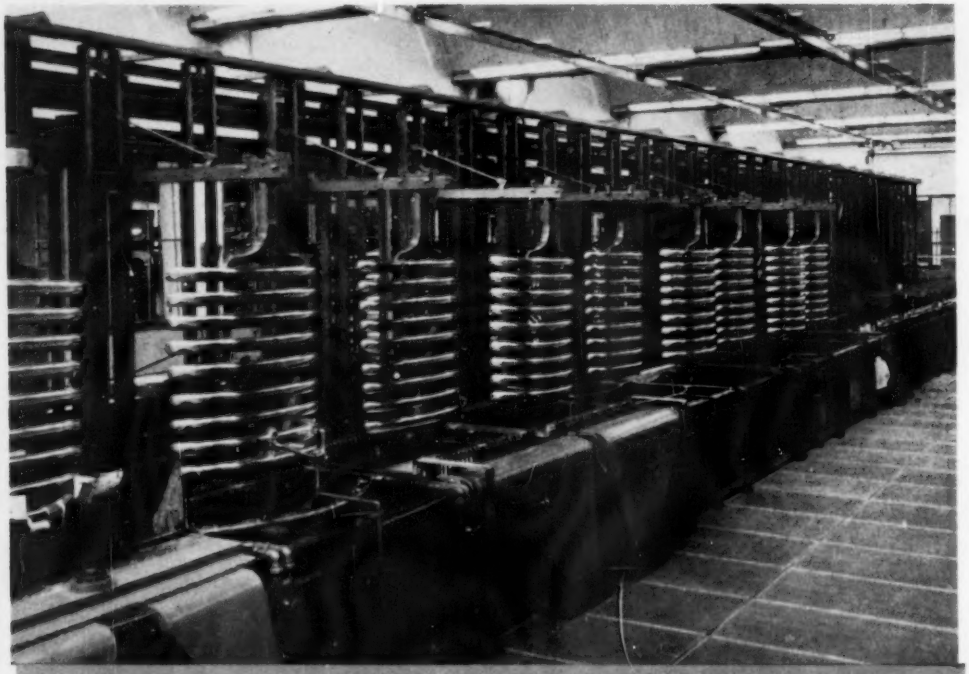

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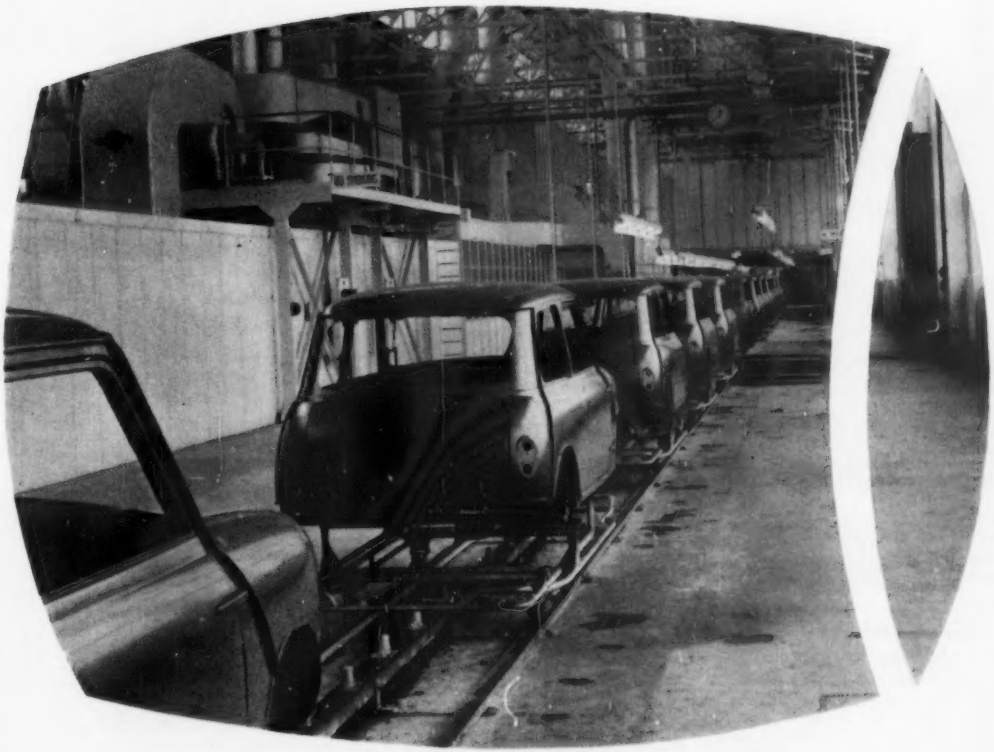

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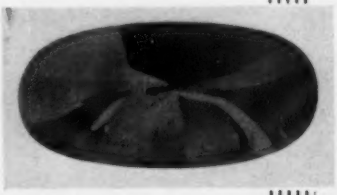

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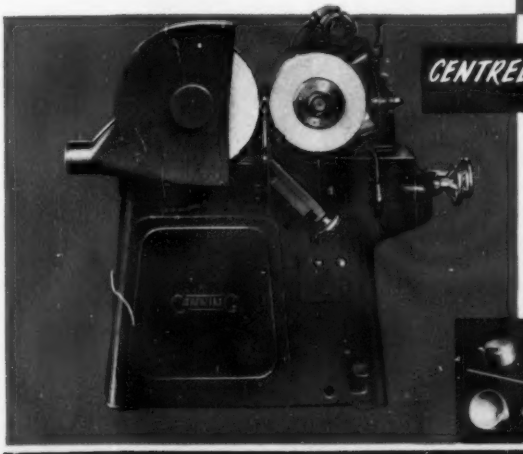

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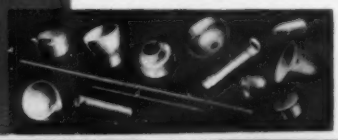

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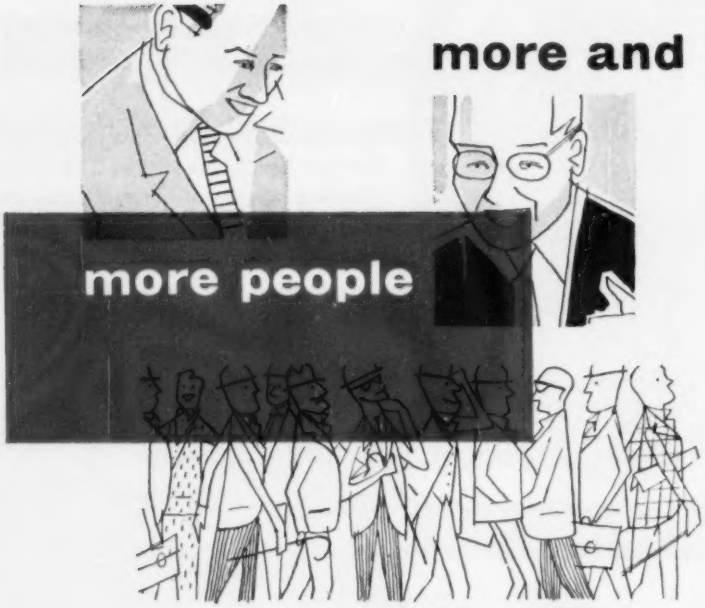

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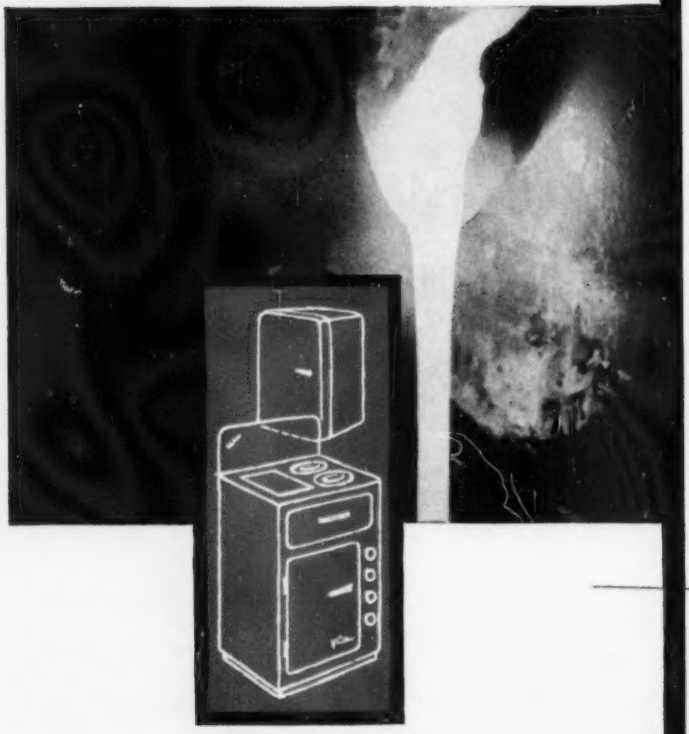

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metal finishing Journal

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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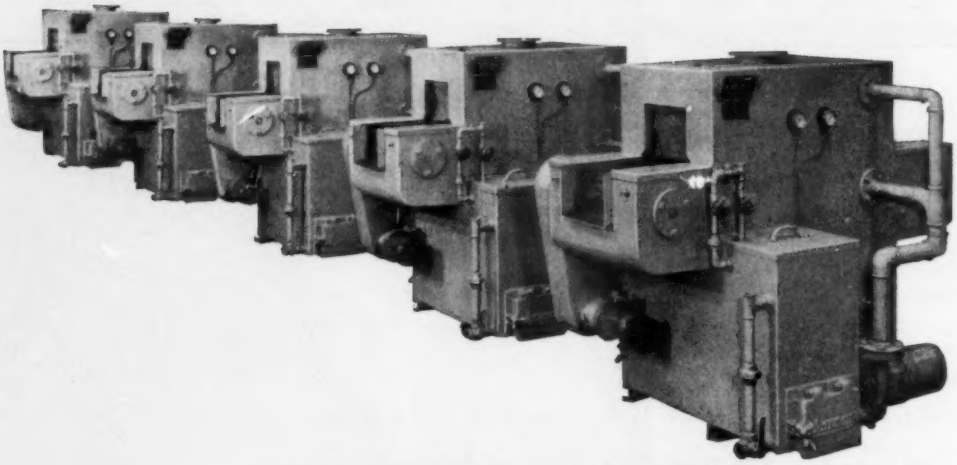
Plant, Processes and Equipment **502**

Metal Cleaning for Mass Production . . .



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GEESE, EGGS AND BASKETS

AS these words are being written the Christmas cards and other expressions of good cheer and good will are beginning to crowd in by every post ; shop windows and even the very streets take on a festive air, while the pavements are thronged with earnest and foot-weary shoppers. Last week the Bank of England announced that the number of bank notes in circulation as a result of the Christmas shopping spree had soared to a record height. There are in fact all the signs of a prosperous and thriving community. Yet in some industries hitherto regarded as the corner stones of our industrial economy, there is news of falling orders and short time working. For those people dependent on an industry at present undergoing a slow-down, celebrations of this year's Christmas holiday may not be entirely unclouded by uncertainties of what the future may bring.

It is unfortunately too easy to propose specious remedies for the afflictions of any industry or section of an industry, and there are as many vociferous amateur economists in times of economic stress as there are amateur strategists in times of war, and we would certainly not presume to add ourselves to their number. On the other hand there are certain factors which seem to be so basic to the problem that although reference has frequently been made to them before, in much more exalted and influential circles than this page can aspire to, they are well worthy of repetition.

The sentiments, which apply, are in fact of such fundamental and widely accepted truth that they can be boiled down into the form of those cryptic tags which one can find as part of the contents of a Christmas cracker or as an inspiring inscription at the foot of a tear-off calendar. The two examples of these ancient adages which seem to apply with particular force in the present circumstances relate to the inadvisability of consigning all ones eggs to a single container and the shortsightedness of making a meal of a goose capable of producing golden eggs.

On the last occasion when the sales of motor cars showed a tendency to fall off, the repercussions throughout the metal-finishing industry were substantial, whereas the evidence today is that this lesson has been learnt and metal finishers have taken steps to diversify their activities, thus rendering themselves less susceptible to the effects of a recession on a specialized front.

Similarly, but perhaps more painfully, realization is dawning that we are all in this economic boat together and that the world does not owe us a living. Increasingly, albeit much too slowly, management and workpeople are coming to recognize their interdependence and the need for a common effort to meet competition in our traditional markets from newly emergent industrial nations.

It is with this hopeful trend in mind that we look forward at this time of Christian rejoicing to a new year of resurgent prosperity.

Season's Greetings

The Editor and Staff of "Metal Finishing Journal" extend to all readers, advertisers, contributors and other friends in the industry at home and overseas, sincere and cordial good wishes for their happiness in the Christmas season and greater prosperity in the Year that lies ahead.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

NO DECISIONS

THE recent I.M.F. Symposium on Bright Nickel Plating can be considered to have been a great success if the numbers attending are a criterion. The meeting certainly attracted a large gathering from all over the country, and a few from overseas.

There seems little doubt that many came with the object of clarifying their ideas on which way the industry is going, insofar as the various alternative nickel and chromium plating procedures now being advocated in different quarters are concerned. But if this was their hope, they must have been very disappointed. As one speaker said, having listened to the papers and the discussion, he was no more in a position to make his mind up as to what to do than he was before. Perhaps he was a little naive in expecting too much from a meeting of this kind.

PLATING IN THE LIMELIGHT

CYNICS are always prepared to suspect the motives of big companies, and the current campaign to restore confidence in plating, largely inspired (and, incidentally, paid for) by the nickel producers has drawn a certain amount of comment to the effect that this is, of course, simply a matter of self interest on their part. Maybe it is—but the plating industry is likely to be the main beneficiary nevertheless.

The effort being put into the campaign is formidable. Press advertising, stands at major exhibitions, including the Motor Show, and now a television series, take a lot of time to prepare and cost a good deal of money—neither of which, it must be admitted, the plating industry or its own trade organizations were prepared to offer, even in a much smaller measure, although the need has for long been evident.

The whole scheme is beginning to bear fruit ; the old criticism that platers are unduly complacent about their product and are doing little to improve it is heard less and less, and well over one hundred firms have now joined the B.S.I. Labelling Scheme. In the past, the nickel interests have only been prepared to give very limited help to platers, having preferred to work through supply houses, whose activities they may have been unduly nervous of cutting across. The new policy has been handsomely vindicated, and widely welcomed; it is hoped that co-operation between anode manufacturers and users will be even closer in the future.

CRIBBAGE

PEOPLE visit overseas trade exhibitions and factories, when they can, for a variety of reasons. Some go to look and be inspired, others to buy, but a great many go with the object of finding something they can copy (or "develop," as it is more elegantly called) when they return home. The plagiarising of other people's ideas is as prevalent in engineering as it is in haute couture, although many would not admit that they ever do so, even to themselves. Probably, in the long run, it does little harm, and being a two-way operation, may do a lot of good by improving standards of design and manufacture everywhere. The difficulty is to know where to draw the line; as someone once put it in a related context : "Copying from one book is plagiarism ; but copying from two books is authorship."

Nevertheless, there is an increasing awareness of the fact that industrial designs should be given some kind of protection on an international scale in the same way as copyright works are, without the necessity for the originator to make separate applications in each country.

It is, therefore, of interest that the Conference recently held in London between the Berne Union Permanent Committee and the Inter-governmental Committee of the Universal Copyright Convention may ultimately give more protection to designers, where it appears to be necessary to supplement existing world patent agreements.

The rights of inventors are very important, particularly as experts are all too ready, when confronted with a new idea, to convince themselves that either "there is nothing in it" or that they knew all about it years ago. Goethe, who was no technologist, understood this when he said : "Is not every new discovery a slur on the sagacity of those who overlooked it?"

TIN-PLATE HOSTELRY

DURING a recent visit to Paris at short notice, I was accommodated at the Hotel du Plat d'Etain, near the Gare du Nord. My mystification as to why the place calls itself the tin-plate hotel remains, despite enquiries from some members of the management and staff. The plates were of china, the cutlery E.P.N.S., and the bathroom fittings chromium, as usual. And being Paris, it is unlikely that much of the food came out of tin cans either.

Recent Advances in ARC-PLASMA METALLIZING*

By

M. A. LEVINSTEIN†

NEW arc-plasma equipment for the spraying of metallic and non-metallic materials are briefly described including a gun for powders and one for wire. With the arc-plasma as a heat source, the highest known melting point materials can be sprayed. With this equipment, specimens were prepared for the determination of selected physical and mechanical properties of arc-plasma deposited materials.

The materials investigated were tungsten, molybdenum, hafnium carbide, tantalum carbide, cerium oxide, zirconium oxide, and hafnium oxide. Tungsten and molybdenum were sprayed in both wire and powder form while the oxides and carbides were in powder form. Spraying parameters were established based on density and microstructure. Selected physical properties measured were density, thermal expansion, and hardness. Crystallographic studies were made to determine stability of the materials under the ultra high temperature spraying conditions. The deposited materials were analyzed for oxygen and nitrogen. Selected mechanical properties measured were tensile strength and elongation for the metals. Test temperatures were room temperature, 1000°F. (538°C.) and 2000°F. (1094°C.). These results are compared with those on bodies prepared by conventional methods.

I. Introduction

The significant activity in the past several years in the field of plasma formation from an electric arc would lead one to believe that this development is of fairly recent origin. In fact, considerable work had been done on plasmas in the first decade of the present century. These early attempts confirmed the theoretical assumptions, but actual operation of plasma-generating equipment was limited to seconds or several minutes before nozzle failure occurred. Following this early work interest lagged because there was little apparent need for an ultra-high-temperature heat source.

However, within the past few years, the interest in high-temperature technology has increased tremendously. This interest had been stimulated by the fantastic demands placed on materials for advanced ram-jet, rocket-motor, and missile applications. To test these materials in the laboratories under conditions simulating actual operation required not only very high heat fluxes but also testing temperatures well above the melting point of all known materials. Consequently, there was a renewed interest in plasma generation and in the development of equipment which would operate for extended periods of time.

This development had been watched with keen interest by those in the metallizing field since the dream of every investigator in this field has been to have a heat source which would melt all known materials and a choice of gases that would not react with the material he was depositing. This development held great promise not only in the field of high-temperature coatings but also in the fabrication of complex shapes.

This paper will describe arc-plasma metallizing equipment for the spraying of wire and powder. The spraying of various metals, carbides, and oxides will be covered and some of the physical and mechanical properties of these materials in both the as-sprayed and heat-treated conditions will be reported.

II. Equipment

A. Wire Gun

Basically, plasma-generating equipment is quite simple in design. An electric arc is formed between an electrode in a plenum chamber through a constricting passage to another electrode. The plasma-forming gas flows from the plenum chamber through this constricting passage. The confining passage and the plasma-forming gas reduce the cross-section of the arc, increasing its density and temperature. Energy is transferred from the arc to the gas, forming the plasma.

For spraying wire, a consumable-electrode, inert-gas unit developed by Henry Libby of the General Electric Co.'s Small Aircraft Engine Department, Lynn Massachusetts, was used. This gun is extremely simple in design and construction (Fig. 1). A 0.040-inch wire is introduced into the gun by means of a wire-feed unit incorporating wire-straightening rolls. The wire is directed through the combined electrode and wire guide. A high-frequency arc starter initiates the arc, and, under certain conditions of operation, helps to maintain the stability of the arc. The arc is

*A paper presented to the annual assembly of the International Institute of Welding, Liège, 1960

†Manager, Metallizing Development Unit, General Electric Co., U.S.A.

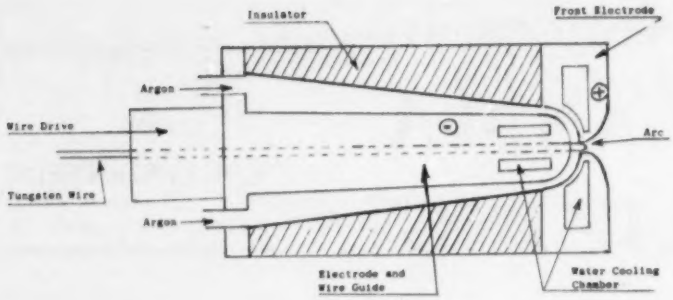


Fig. 1.—(left) Schematic diagram of wire arc spray gun.

Fig. 2.—(below) Modified wire arc spray gun in operation.

formed between the negative electrode and the water-cooled nozzle which serves as the positive electrode. The arc transfers from electrode to the wire and is stabilized by the flow of high-pressure argon gas.

The gun can be operated using various power sources, including (1) a 300-amp. d.c. motor-generator arc welder, (2) a 300-amp. d.c. single-phase rectifier, (3) a 3-phase rectifier, and (4) other arc-welding equipment. High-density deposits have been obtained using either straight or reverse polarity. However, nozzle life is significantly increased using reverse polarity (wire negative, nozzle positive). With the wire as the anode, a plasma-type arc loop is formed which attaches itself to the cathode and moves slowly around the nozzle orifice. The original design operated under the following settings :

voltage	56 to 65
amperes	200
wire speed	40 to 100 inches per minute
argon	50 to 400 lb. per sq. in.

Using tungsten wire, a speed of 100 inches per minute represents a deposition rate of 2.5 kg. per hour. The quality of the deposit and the deposition efficiency was better at the higher gas pressures. With the higher pressures the spray pattern was more confined, a finer spray was produced, and the particle velocity was increased. Under these conditions, particle-size distribution was as follows :

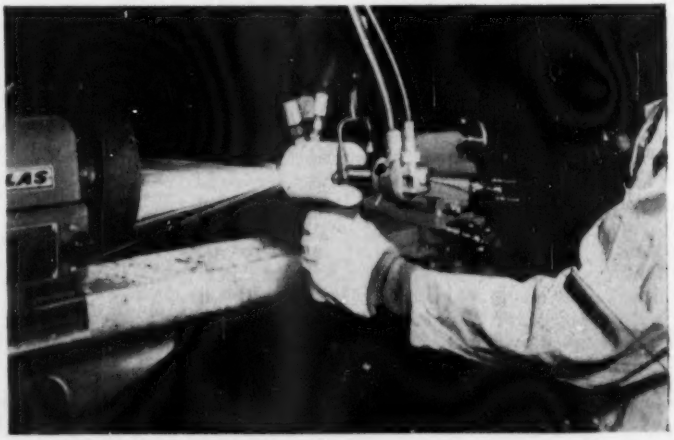
Mesh size	Per cent
−100	12.2
−100, +200	27.8
−200, +325	21.7
−325	33.3

It is recognized that apparent particle size as determined by the water collection method may be finer than actual since there is some fragmentation of the molten particles on striking the water.

Modification of the original design has been made which permits operating at higher amperage and lower voltage with a significantly greater feed rate and lower gas pressure. The results of a recent study are listed below. These results were obtained with the voltage held constant at 40 volts and the gas pressure at 50 lb. per sq. in.

Wire feed rate, in. per min.	Kilowatts	Kg. per hour	Kg. per kW
100	11.6	2.55	0.220
150	14.0	3.82	0.273
200	16.4	5.10	0.311
250	17.6	6.37	0.362
300	18.0	7.65	0.425
350	18.2	8.92	0.490
400	18.8	10.20	0.542
450	19.5	11.73	0.601

From these results a five-fold increase in deposition rate and a three-fold increase in energy transfer efficiency was observed. Fig. 2 shows this modified gun in operation.



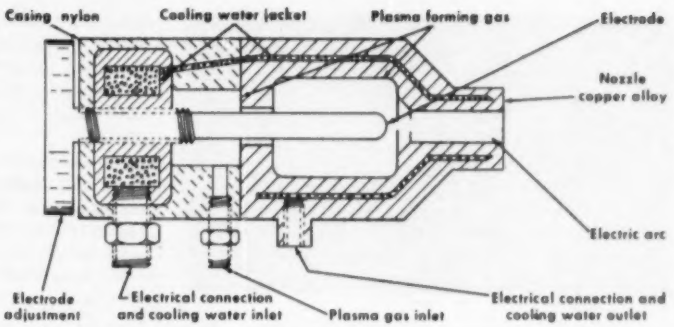


Fig. 3.—Schematic diagram of powder arc-plasma gun.

B. Powder Gun

The powder gun operates on the non-consumable arc principle and a schematic diagram is shown in Fig. 3. This equipment was obtained from the Thermal Dynamics Corporation, Hanover, New Hampshire, U.S.A. The plasma is formed in the throat of the water-cooled nozzle. Approximately $\frac{1}{4}$ inch from the end of the nozzle, a hole is provided for the introduction of the powder. The gun is operated from two 600-amp. motor-generators and is rated at 40 kW.

Whereas the wire gun can only be operated using argon, a number of plasma-forming gases can be used with the powder gun. Reported plasma temperature, enthalpy, energy transfer efficiency for various gases are listed below :

Gas	Power, kW	Calculated plasma, T°F.	Enthalpy, BTU per lb.	Arc voltage	Efficiency (per cent)
N_2	60	13,200	17,900	65	60
H_2	62	9,200	138,000	120	80
He	50	36,000	92,000	47	48
A	48	26,000	8,400	40	40

From the table, it would appear that hydrogen would be the best gas to use, not only for its high enthalpy and efficiency of heating, but also for its low cost. However, when hydrogen alone is used as a plasma-forming gas, it has a very erosive effect on the nozzle and greatly reduces nozzle life. For long nozzle life, the percentage of hydrogen must be reduced to 10 volume per cent, the balance being nitrogen. This mixture was used in much of the work which will be reported in subsequent sections.

III. Investigation

The overall objective of this investigation was to determine the mechanical and physical properties of a number of materials with melting points above 4500°F. (2480°C.) deposited by the plasma spraying process. These properties included density, hardness, tensile strength, crystallography, and thermal expansion. Where applicable, determinations were to be made both in the "as-sprayed" and heat-treated condition. In addition, the oxygen and nitrogen contents were to be determined. Included in the study were tungsten, molybdenum, tantalum carbide, hafnium carbide, cerium oxide, zirconium oxide, and hafnium oxide.

A. TUNGSTEN AND MOLYBDENUM

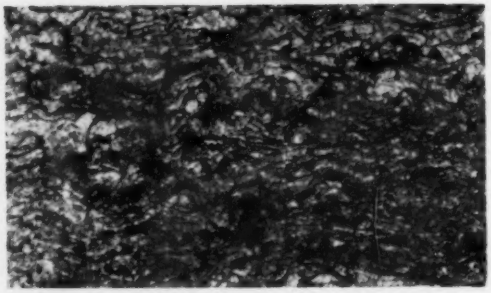
1. Sample Preparation

The tungsten and molybdenum specimens were prepared by spraying on a 0.75-in. O.D. aluminium tube which serves as a mandrel. Aluminium was selected because it can readily be leached from the sprayed deposits by alkaline reagents with no contamination or reaction with the sprayed metals. The tube configuration was chosen to allow internal cooling during deposition. The mandrel was chucked in a lathe and rotated to assure a uniform deposit. For the wire-sprayed specimens, 0.040-in. wire was used. Wire speed was 100 inches per minute. The powder specimens were prepared under the following conditions :

Power input to gun	28 kW
Plasma forming gas	90 cu. ft. per hr. N_2—10 cu. ft. per hr. H_2
Particle size	—200, 325 mesh
Gun to work distance	2 to 3 inches
Powder carrier gas	10 cu. ft. per hr. N_2
Powder feed rate	6 lb. per hr.
Calculated plasma temperature	9500°F. (4960°C.)

The higher power operation of the powder-spraying equipment produced a hotter and longer flame than the wire-spraying equipment. It was necessary to divert the plasma flame from direct impingement on the deposited material to prevent overheating and oxidation. This was done by directing a narrow blast of shop air at the exiting plasma. Blast pressure was adjusted to divert the plasma without deflecting the particles.

Under the above conditions, cylindrical specimens 4 in. long with a 0.300-in. wall were produced. Removal from the mandrel was accomplished by leaching in a cold 50 per cent NaOH solution for approximately 30 minutes. Longitudinal sections



were cut from the cylinders. Some of these sections were set aside for evaluation of the " as-sprayed " material and the balance of the sections were heat treated. The wire-sprayed specimens were heat treated in hydrogen at 3600°F. (1983°C.) for one hour. The powder-sprayed tungsten was heat treated at 4000°F. (2200°C.) in vacuum for two hours. The powder-sprayed molybdenum was heat treated in hydrogen for two hours at 2150°F. (1158°C.) and in vacuum for two hours at 4000°F. (2200°C.).

2. *Gas Analysis*

Gas determinations for oxygen and nitrogen were made on both the " as-sprayed " and heat-treated materials. Analysis was by the vacuum-fusion technique.

Material	Condition	Oxygen	Nitrogen
W—wire	as sprayed	0.254	0.011
W—wire	hydrogen H.T. 3600°F./1 hr.	0.007	0.0002
W—powder	as received	0.113	0.0017
W—powder	as sprayed	0.814	0.024
W—powder	vacuum H.T. 4000°F./2 hr.	0.011	0.0005
Mo—wire	as sprayed	0.897	0.038
Mo—wire	hydrogen H.T. 3600°F./1 hr.	0.011	0.0005
Mo—powder	as received	0.052	0.0033
Mo—powder	as sprayed	1.02	0.103
Mo—powder	vacuum H.T. 4000°F./2 hr.	0.071	0.0001

These results indicate that while the nitrogen pick-up is relatively low during the spraying operation, there is considerable oxygen pick-up even though the wire is sprayed with argon gas. It is realized that some of this pick-up may be due to oxidation of the deposited material while the specimen was being prepared. However, this can only be determined if the spraying is done in a tank under an inert atmosphere.

Fig. 4.—(*above, left*) (*x* 100) *As-sprayed tungsten wire,* (*top*) *unetched,* (*bottom*) *etched.*

Fig. 5.—(*left*) (*x* 6000) *Electron micrograph, as-sprayed tungsten wire.*

3. *Density*

Density determinations were made on both the as-sprayed and heat-treated materials using a water-displacement method. The accuracy of the water-displacement technique was verified by comparison with accurately machined specimens by direct weighing. The as-sprayed densities of the wires were approximately 2 per cent greater than that of the powders. The 3600°F. (1983°C.) sintering treatment increased the density of the wire sprayed deposits 2.0 to 2.5 per cent and the powder sprayed deposits 1.5 to 3.0 per cent. Results are listed below :

Material	As-sprayed Density % theoretical	Heat-treated Density % theoretical
W—wire	85.0—87.0	87.0—89.0
W—powder	83.0—84.0	84.5—85.5
Mo—wire	88.0—89.0	90.5—91.5
Mo—powder	86.2—87.1	89.3—90.2

4. *Hardness.*

Hardness values were obtained with a Vicker's hardness tester using a 1-kilogram load. Hardness readings were taken on specimens that were metallographically mounted and polished.

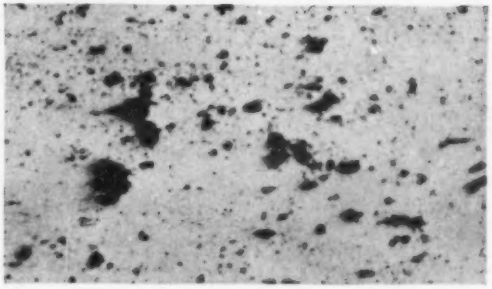
Material	VHN As-sprayed	VHN H.T.
Mo—wire	168—183	155—159
Mo—powder	321—368	125—175
W—wire	246—263	238—255
W—powder	330—390	162—200

Annealed wrought molybdenum has a hardness of 165 VHN and annealed wrought tungsten 375 VHN. The lower values obtained on the sprayed material may be due to the porosity of the material.

5. *Microstructure.*

Photomicrographs of the as-sprayed and heat-treated structures of the wire-sprayed tungsten and molybdenum deposits are shown in Figs. 4, 5, 6 and 7. Fig 4 shows the as-sprayed structure of tungsten at 100X in both the unetched and etched condition. The structure is typically lamellar with with scattered large voids throughout the structure. Greater detail is revealed in Fig. 5, an electron micrograph at 6000X. This photomicrograph shows the bonding between the lamellar and the sub-grain structure of the individual platelets. A one-hour hydrogen heat treatment at 3600°F. produces some changes in the structure, Fig. 6. Considerable recrystallization has taken place but there is still evidence of the original lamellar structure.

Fig. 7 shows the microstructure of the as-sprayed molybdenum wire and the structure after the one-hour hydrogen heat treatment at 3600°F. The as-sprayed structure, top, has fewer large voids



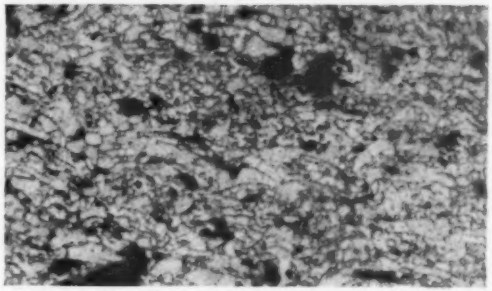


Fig. 6.—(above) (x 100) Sprayed tungsten wire after 1-hour heat treatment at 3600°F. in hydrogen. Top: unetched. Bottom: etched.

Fig. 7.—(below) (x 100) Sprayed molybdenum wire. Top: as-sprayed, etched. Bottom: 3600°F. heat treatment for 1 hour in H_2, etched.

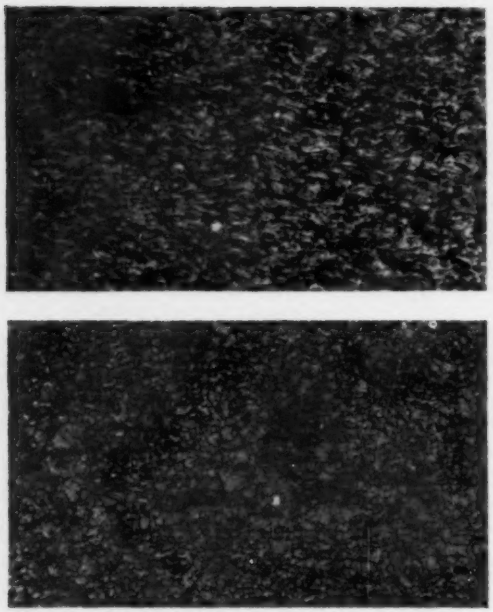


Fig. 8.—(x 100) Sprayed tungsten powder. Top: As-sprayed etched. Bottom: 4000°F. heat treatment for 1 hour in vacuum.

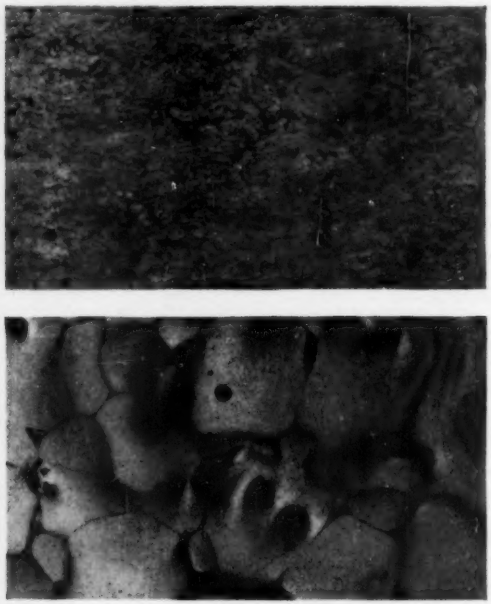


Fig. 9.—(x 100) Sprayed molybdenum powder. Top: As-sprayed, etched. Bottom: 4000°F. heat treatment for 1 hour in vacuum.

than the as-sprayed tungsten (Fig. 4). The 3600°F. heat treatment completely eliminated the lamellar structure through the mechanism of recrystallization and grain growth.

The structures of both the as-sprayed powder tungsten and molybdenum deposits are significantly different than the wire-sprayed materials (Figs. 8, top, and 9, top). The lamellae are smaller and of more uniform size. Voids, also, are considerably smaller and much more uniformly distributed.

The heat-treated structure (Figs. 8, bottom, and 9, bottom), also show noticeable differences. The recrystallized grain-size of the powder-sprayed tungsten is much finer than that of the wire-sprayed tungsten despite a higher heat-treating temperature, 4000°F., and a longer time at temperature, 2 hours. However, these same heat-treating conditions produced a massive grain growth in the powder-sprayed molybdenum deposits, (Fig. 9, bottom).

6. *Tensile Properties*

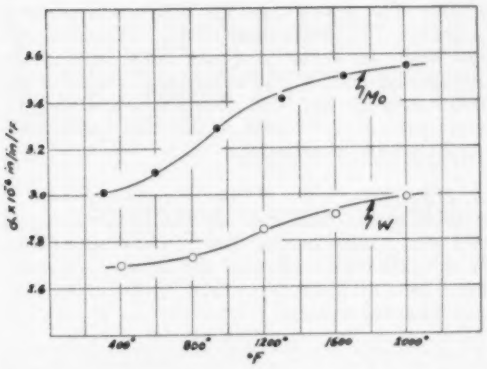
Tensile properties were determined only on the heat-treated materials since the as-sprayed deposits were too brittle to be machined into tensile specimens. A button-head-type tensile specimen was used having a 1-inch gauge length and a 0.160-in. diameter.

Even the heat-treated specimens needed special precaution in machining. Very light feeds were required to prevent breakage.

Tensile tests were run at room temperature, 1000°F. (538°C.), and 2000°F. (1094°C.). The elevated temperature tests were conducted in an evacuated capsule at an absolute pressure of 1×10^{-4} mm. of mercury. A head travel rate of 0.01 inches per minute was maintained during testing.

Material	Sintering treatment	Tensile strength, lb. per sq. in.		
		Room temperature	1000°F.	2000°F.
Tungsten wire	H_2-3600°F./1 hr.	5,200	—	10,500
Tungsten powder	Vac-4000°F./2 hr.	6,700	20,300	15,300
Molybdenum wire	H_2-3600°F./1 hr.	13,750	—	15,600
Molybdenum powder	H_2-2150°F./2 hr.	—	—	6,600
Molybdenum powder	Vac-4000°F./2 hr.	30,500	—	10,500

All specimens failed in a brittle manner except the powder molybdenum specimens heat treated in vacuum at 4000°F. These specimens had an average elongation of 23 per cent in one inch, and a reduction of area of 24 per cent. The powder tungsten specimens showed a very slight elongation of approximately 0.5 per cent. It is significant to note that the 2000°F. strength of the molybdenum wire-sprayed samples was 50 per cent higher than



the powder-sprayed sample but that the former had no ductility. Apparently, the high sintering temperature and longer heat-treating time is needed to impart ductility to the material. The effects of high sintering temperature and longer sintering are more pronounced on room temperature strength where the 4000°F. sinter for 2 hours yielded a 30,500 lb. per sq. in. strength compared with 13,750 lb. per sq. in. after a 1-hour heat treatment at 3600°F. However, this may be due, in part, to differences in as-sprayed structure since the former was powder sprayed and the latter wire sprayed.

7. *Crystallographic Structure*

X-ray diffraction studies showed the lattice parameter of the wire-sprayed tungsten to be $a_o = 3.164$Å which is identical with the ASTM accepted value for tungsten. The diffraction lines were broader than are commonly found and resolution of the Co $K\alpha_3$ and Co $K\alpha_2$ did not appear. This lack of resolution may be due to the presence of micro-stains since the material was in the as-sprayed condition. The powder-sprayed tungsten showed a slightly larger value, $a_o = 3.1656$Å. The lattice parameter of the heat-treated wire sprayed molybdenum was $a_o = 3.1534$Å which is slightly larger than the accepted value of 3.1472Å.

8. *Thermal Expansion*

Thermal expansion measurements were made on 0.190-in. diameter bars 2.5 in. long from room temperature to 2100°F. (1150°C.). Expansion was measured using a Chevenard Dilatometer and the results are shown in Fig. 10.

B. CARBIDES

The carbides selected for investigation were hafnium carbide, m.p. 7030°F., and tantalum carbide, m.p. 7010°F. The initial specimens were sprayed with the powder gun under the same spraying parameters used for spraying tungsten and molybdenum with a 90 per cent N_2-10 per cent H_2 mixture as the plasma-forming gases. The microstructure of the deposited hafnium carbide is shown in Fig. 11. Examination of the microstructure shows the presence of more than one phase, indicating that some transformation

Fig. 10.—(above) Thermal coefficient of expansion curves for sprayed molybdenum and tungsten.

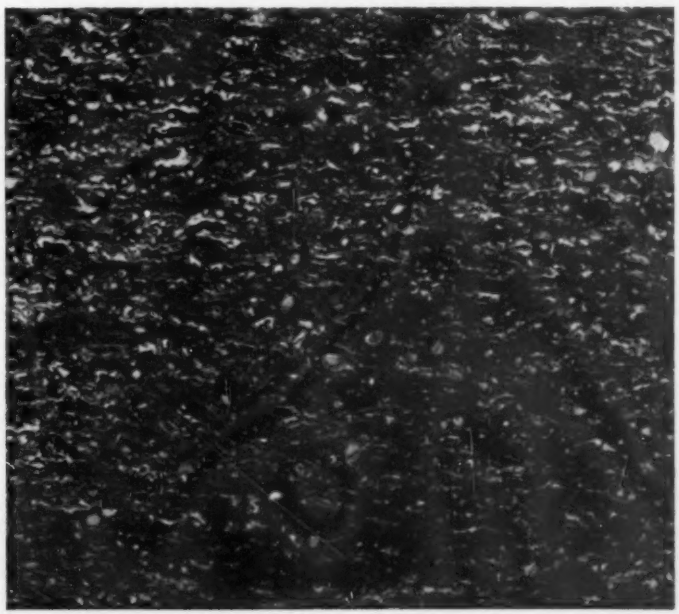


Fig. 11.—As-sprayed hafnium carbide powder.

of the hafnium carbide has occurred during the spraying operation. A similar condition was observed with the sprayed tantalum carbide. Before proceeding with any properties evaluation, it was necessary to determine the nature of the transformation that had taken place.

X-ray diffraction patterns of the " as-received " hafnium carbide and tantalum carbide powders were studied first to establish their purity. In each case, the patterns showed only the lines for hafnium carbide and tantalum carbide respectively. No other compounds or phases were detected.

The X-ray diffraction patterns produced by the sprayed materials were poor in quality due to microstrains and distortions in the lattices. By heat treating the deposits at 2000°F. (1094°C.) in vacuum, resolution was improved and Hf (C, N) HfO_2 and Hf were detected in deposits from the HfC powder and Ta_2C and Ta in the deposits from TaC powder. In the latter case, no TaC was found in the deposit. From these results, it is apparent that there is some dissociation of the HfC and TaC at the high plasma temperature.

This was confirmed by chemical analysis of the deposited materials.

Material	Chemical analysis			
	Metal	Carbon	Nitrogen	Oxygen
Hafnium carbide	94.1 per cent	2.92 per cent	0.858 per cent	1.88 per cent
Tantalum carbide	93.1 per cent	1.12 per cent	0.326 per cent	1.96 per cent

The stoichiometric composition of HfC is 93.6 per cent Hf and 6.31 per cent. C, and that of TaC 93.77 per cent Ta and 6.23 per cent C. Apparently, there is a considerable loss of carbon during the spraying operation due to dissociation. The decomposition of the TaC proceeded to a much greater extent in that less than 20 per cent of the original carbon had been retained. The high nitrogen content, 0.858 per cent, of the deposited HfC confirms the presence of the complex Hf (C, N) since the maximum retained nitrogen in the tungsten and molybdenum deposits was 0.103 per cent. The 0.376 per cent nitrogen present in the deposits from TaC powder would indicate that some TaN may be formed. The high oxygen contents in both deposits, 1.88 per cent and 1.96 per cent, are strong evidence for HfO_2 and TaO_2 being present.

Since it was demonstrated that the nitride was being formed using nitrogen as the plasma-forming gas, subsequent spraying was conducted with an argon hydrogen mixture to form the plasma. The patterns of these deposited materials were appreciably different. The sprayed HfC powder showed a major amount of HfC and minor amounts of HfO_2. The deposit from the TaC powder showed primarily TaC with some Ta_2C. However, the resolution was rather poor, and since some of the lines of Ta and TaC are fairly close, Ta may have been present but not detected. Considerably more work is to be done in this area before fully accurate data is available.

C. OXIDES

Work on the oxides has only recently been started and the results to date are rather fragmentary. X-ray diffraction studies of the sprayed deposits, have been made on two oxides, CeO, ZrO_2, with the following results :

Oxide	System	Latter a_o measured	a_o-ASTM
CeO	FCC	5.411Å	5.411Å
ZrO_2	Cubic (stabilized)	5.123Å	5.07Å

The higher reading for ZrO_2 is due to the 5 per cent addition of CaO for stabilizing purposes.

Hardness and density determinations also have been made.

Oxide	VHN	Density	% theoretical
CeO_2	168 to 205	6.58 gm. per cc.	92.3
ZrO_2	636 to 805	5.14 gm. per cc.	92.4
HfO_2	251 to 313	8.39 gm. per cc.	86.8

IV. Discussion

It has been demonstrated that the highest melting point materials can be sprayed successfully with the arc-plasma equipment. For the spraying of tungsten and molybdenum the powder method appears to be more advantageous.

The powder deposits have a much more uniform as-sprayed structure and a finer sintered structure than the wire-sprayed material.

Though the wire-sprayed deposits are more dense in the as-sprayed condition, no beneficial effects are apparent in subsequent heat treatment.

In addition, the price of tungsten and molybdenum powders are approximately one-fifth the price of the metals in wire form.

Wire spraying has definite advantages in that deposition rates are significantly higher and that the power requirements are considerably lower. Furthermore, the equipment requirements are relatively inexpensive compared with the powder gun equipment.

Appreciable amounts of nitrogen and oxygen were retained in the deposits during the spraying operation. The nitrogen-plasma forming gas was probably the major source of the retained nitrogen

(*Continued in page* 476)

SATIN FINISHES ON AUTOMATIC POLISHING MACHINES

Some Details of the Use of Water-Based Liquid Polishing Compositions

By F. W. ANDERSON *

THE use of water-based liquid polishing compositions in this country on automatic equipment for large-scale production has been established and emphasized more by the importance of the user than by the number of users. Their quality as a buffing compound is high since there is very little variation in viscosity and separation is non-existent.

The development of the compositions has followed the remarkable reorganization of the industry over the last three years and it is not surprising that users should want to extend the scope of liquid buffing compounds into other fields. In the last twelve months the use of liquid greaseless compositions primarily based on what is known as ' cold cement ' has been developing.

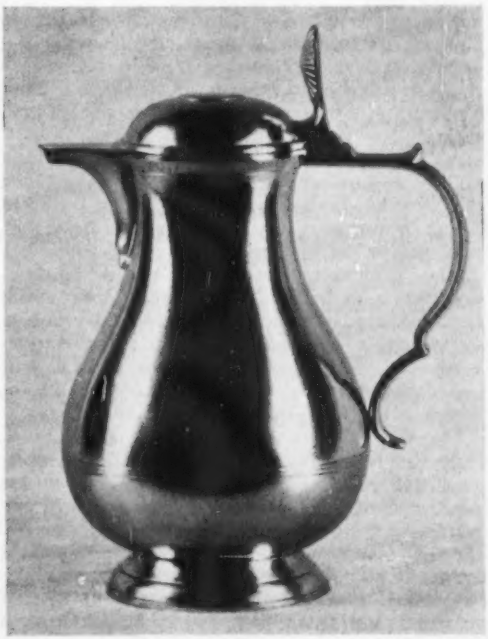
Two years ago the author's founder company in Connecticut was asked to provide a greaseless compound which could be used to give a satin finish on brass, prior to silver plating lipstick cases, based on a number of rotary automatics. It had already been accepted that the original compound, based on a very high-quality hide glue, could not be used on automatic equipment in conjunction with normal mechanical applicators, because as soon as the bar was exposed to the air it hardened, and therefore its use became uneconomic.

As a result, the chemists turned their attention to one of their cold cements which already had a reputation for tenacity and was being used by a number of customers to make simple mixtures by adding grain and brushing it onto the polishing wheels. These simple mixtures served a useful purpose but were unstable, easily separated with the grains dropping to the bottom of the container and making it almost impossible to maintain any form of homogeneity. The laboratory therefore set out to make a special binder in an effort to mitigate this problem, but even then the resulting compound had the disadvantage of all cold cements, namely that the head was extremely rigid, prohibiting its use for satin-finishing operations on contoured items. Other experiments were made and eventually a new binder was developed having a flexibility about halfway between that of cold cement and a first-class greaseless buffing compound. The new product (called " Plasti-Brade Red ") settled many of the problems of applying a greaseless compound to buffs on automatic polishing machines and the job on the silver-plated lipstick cases was done with string brushes at very low peripheral speeds. The compound was sprayed onto the wheels using conventional guns with modified nozzles and needles to give as perfect an air seal as possible when the gun was not delivering. It should be appreciated, of course, that it is essential to use a fast-drying media in compounds formulated for satin finishing.

The scope for this sort of material was quickly realized, not only for satin finishes but also to take the place of the messy old-fashioned glue pot,

(*Continued in page* 476)

Fig. 1—*Typical satin finish on stainless-steel jug*



* The Lee Manufacturing Co. of England Ltd.

Satin Finishes on Automatic Polishing Machines

(*Continued from page 475*)

tray of grain and brush. Weight was added to argument by virtue of the fact that it was not good policy to attempt to use a grain of grit size coarser than 180 in a normal liquid buffing compound, but a grain size as large as 60 could be used quite effectively in a cold cement-based liquid compound.

The use of spray guns with the coarser grades of these liquid compounds below 200 grit was not too satisfactory, as the lines and guns had to be frequently cleaned. There is, however, in the United Kingdom a well-known manufacturer investigating this problem.

The claim of efficiency and tenacity for these compounds has made quite large users temporarily give up the idea of using guns and dress the wheels with either good-quality brushes (the bristles of the ordinary glue brush are far too coarse for this purpose) or mohair paint rollers.

It is worth mentioning that a year ago a colleague in Toronto, who had developed a profitable method of re-heading small belts with a greaseless compound, proved that it was possible to re-head conventional abrasive belts up to almost any size. This technique gave immediate impetus to the demand for these compounds and now one company is regularly re-heading belts 16 in. wide by 23 ft. long. It had been most successful on glue bonded belts and the resistance of certain resin-bonded belts is being investigated.

In all cases users have stated that they are getting a better micro-finish at every stage, cutting out operations and making considerable savings on the cost of buffs and other types of wheels. They find also that they can use a higher grit number without any increase in polishing times.

Although emphasis has been placed on satin finishes in particular, it will be readily appreciated that such finishes can be quickly brought to buffed bright or mirror in one, or certainly not more than two, grease bar applications.

The general experience on re-heading conventional belts is that "Plasti-Brade Red" heads last from 40 to 60 per cent of the life of a new belt. Good quality belts will take from two to six re-heads before they are thrown away. It is estimated that the total cost of re-heading is in the region of 4s. per square foot of surface.

On the subject of micro-finish, there is an interesting case from a firm working on stainless-steel flat pieces. The work is brought to the pinch roll machine at a 30 micro-in. C.L.A. and processed using calico buffs and Plasti-Brade 500 for 45 seconds, resulting in a surface finish of approximately 1 micro-inch. This is rather phenomenal, but points to the fact that these new materials and techniques should be investigated

Fig. 2—String wheel

to see where they could fit into any particular production programme. Every firm should therefore be prepared to do a certain amount of experimentation on their own problems, because, except where there is recorded experience, it is difficult to assess the difference between the conventional polishing wheels and the liquid greaseless compounds. Using conventional polishing wheels, dry grain sits on the surface and is held in position by the underneath coating of animal glue or cold cement. In other words, there is an unprotected head which falls in cutting propensities as it starts to wear. On the other hand, with the new compositions the grain is suspended in the binder and the cutting capacity of the wheels remains the same from the nap to the buff.

Advances in Arc-Plasma Metallizing.

(*Continued from page 474*)

though some nitrogen was aspirated from the surrounding air. The high oxygen contents were due primarily to oxidation of the specimen during spraying and secondarily to oxygen aspirated into the plasma stream. To determine more accurately the sources of oxygen and nitrogen, it would be necessary to do the spraying in a controlled atmosphere tank. Future experiments are planned under controlled atmospheric conditions.

The property data obtained to date is still of a preliminary nature. Many additional tests are planned including: (1) 3500°F. and 4500°F. tensile tests on tungsten, (2) compressive modulus and transverse rupture on the non-metals, (3) specific heat, and (4) resistance to thermal shock.

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Technical Developments and Advances in NICKEL-CHROMIUM PLATING

Discussed at One-Day Symposium Organized by THE INSTITUTE OF METAL FINISHING

A ONE-DAY symposium, organized by the Institute of Metal Finishing, was held at the Festival Hall, London on November 16. In association with the Institute, the London branch arranged an exhibition to illustrate the technical developments and advances in nickel and chromium deposition. Displays were offered by most of the leading supply houses.

The exhibit of **Albright and Wilson (Mfg.) Ltd.,** included production items plated using Plusbrite addition agents, together with examples of Plusbrite Duplex plating. The excellent levelling characteristics of these additives were shown, together with the corrosion resistance provided by Duplex. Chemically-polished brass and some samples plated in a copper pyrophosphate electrolyte using a new addition agent were also on show. **M. L. Alkan Ltd.,** displayed samples of various accelerated corrosion tests undertaken to demonstrate the advantages of Duplex and crack-free chromium. The sulphur-dioxide testing apparatus and the recently developed B.N.F.M.R.A. coulometric thickness testing meter were also shown.

The results of an evaluation of improved methods of plating zinc-alloy die castings were presented by the **British Non-Ferrous Metals Research Association** to show the advantages to be gained from the use of thicker chromium deposits applied under conditions giving crack-free coatings. Articles plated with Duplex nickel and crack-free chromium exposed in an outdoor atmosphere could be seen. The **W. Canning** exhibit illustrated the research and development work into Duplex nickel and crack-free chrome corrosion-resistant deposits. This was done by means of micrographs of corrosion attack on coatings, comparative test panels of conventional deposits and the new corrosion resistant nickels and chrome.

Sample components plated in dull nickel, A101, M.101 bright nickel and D.303 semi-bright (sulphur free) duplex system plating processes, together with crack-free chromium plating, was displayed on the stand of **R. Cruickshank Ltd.** The relative merits of these processes under standard corrosion conditions were demonstrated, following corrosion tests using the sulphur dioxide cabinet. **Electro-Chemical Engineering Co. Ltd.,** had samples of the Efco-Udylite 66 bright nickel process and their N.2.E semi-bright nickel process was also to be seen with hub caps and door handles which had been subjected to outdoor atmospheric exposure tests and accelerated exposure tests. **Harshaw Chemicals Ltd.** were showing their semi-bright and bright nickel plating processes and **Metals and Methods Ltd.,** who have been comparing oxygen-containing nickel anodes and carbon-containing nickel anodes used in a dull Watts solution with similar anodes used in proprietary organic bright solution under normal operating conditions, illustrated the graining effect on depolarized nickel anodes which occurs in many of the bright solutions currently being used. The carbon-type nickel anodes, it is claimed, do not exhibit graining in these solutions, and produce less wastage.

The Mond Nickel Co. Ltd. explained the principles of their labelling scheme and demonstrated the coulometric test and the British Non-Ferrous Plating Gauge. Special corrosion-resistant deposits, at usual coating thicknesses, obtained by using a pure nickel electrolyte could be seen on the stand of **Omnium Engineering Ltd.** This pure nickel electrolyte precipitates compact and ductile deposits free of sulphur and having good absorption for hydrogen.

Production samples plated with Superbrite and Supersonic bright nickel processes were displayed on the stand of **Silvercrown Ltd.** Various components, including zinc-base die-castings, had been processed in manual, semi- and fully-automatic plants.

Sonic Engineering and Equipment Ltd. exhibited components processed in one of their Lift-o-Matic plants. These plants are fully automatic and suitable for all types of finish. The advantage claimed for this plant over more conventional automatics is the small floor area taken. Its design is simple and less solution and d.c. power is required.

* * *

Four technical papers were presented at the Symposium, abstracts of two of which, together with the discussion that ensued following their presentation are published below. The remaining papers and discussion will be published in a future issue.

Abstract

REVIEW OF RECENT DEVELOPMENTS IN NICKEL PLATING

by H. C. Castell. *

THE author reviews decorative nickel plating over the past ten years and pays particular attention to studies of the behaviour of nickel and chromium coatings under corrosive atmospheric conditions. He suggests that the greatest advance towards the understanding of the mechanism of corrosion break-down of electrodeposited nickel and chromium coatings was made by *Wesley* and *Knapp* who reported tests demonstrating that inherent porosity in the deposits was not the principle cause of breakdown. They concluded that failure more often occurs by pitting corrosion caused by electrochemical activity at the sites of discontinuities in the chromium top-coat.

Most of the work done up to this time had been concerned with dull nickel deposits, but some experiments with bright-nickel coatings, carried out in the United States, were beginning to reveal inconsistencies in the corrosion behaviour of bright-nickel deposits under chromium topcoats.

The author considers that it is now clear that the performance of bright-nickel deposits is inextricably linked with the nature and properties of the chromium topcoat, and although there is as yet no tried-and-proven explanation, some suggestions have been made to explain the inconsistencies in the behaviour of bright-nickel and chromium deposits. First, cracking of fine-grained bright-nickel coatings is believed to be promoted by chromium plating. *Sample* has stated that although such nickel deposits are in a macro-sense stress-free, or even compressively stressed, there is evidence of considerable stresses within the crystallites themselves. Second, nickel deposits containing sulphur, incorporated as the organic sulphur-containing agent, are said to be less noble than deposits free from sulphur. There is little incorporation of sulphur from any other source since the nickel ion involved in deposition is coordinated with water molecules, and the hydrated sulphate ion, being negatively charged, plays no part in the actual deposition process.

Radiotracer examination of nickel deposits obtained from solutions containing labelled sulphate has indicated that the sulphur/nickel atom ratio was considerably lower than in the deposits from solutions containing thiourea. The incorporation of sulphur in deposits from solutions containing thiourea was found to vary inversely with the current density. Thus the addition of a sulphur-containing agent results in the incorporation of a far greater amount of sulphur than is present in deposits from solutions containing sulphur in the form of sulphate only.

Recent Russian work has shown that when brighteners such as thiourea are used colloidal nickel sulphide forms at the cathode. It is suggested that brightness and levelling are achieved by the intermittent adsorption and reduction of nickel sulphide, with consequent increase and decrease in cathode polarization. These findings suggest that bright-nickel deposits formed in solutions to which appropriate sulphur-containing brightening agents have been added are more readily corroded than pure nickel or deposits made from solutions which are sulphur-free.

Discussing brightness, levelling and throwing power the author says that levelling power has been shown to be due to the preferential adsorption on surface peaks, of organic materials which have the power to increase polarization of the cathode surface and thereby reduce the local rate of deposition. It is also suggested that both brightness and levelling are achieved by smoothing mechanisms. Mention is also made of the attention drawn by *Watson* to the affect of organic addition agents on throwing power, and that throwing power as well as levelling, changes when certain organic chemicals, such as thiourea and coumarin, are added in various concentrations to the plating solutions.

The principal test techniques to determine the corrosion behaviour of decorative nickel and chromium coatings is dealt with in great detail and an interesting comparison made of the differences between them. Mention is made of a suggestion by *LaQue* that a standard accelerated test must be capable of :

(1) Measuring the continuity of a coating.

(2) Reflecting the thickness, uniformity and protective value of a coating, by creating pores or other discontinuities in a systematic way, at a rate which can be duplicated from test to test, and can be related to a widely representative practical environment.

(3) Observing galvanic effects between the coating and the basis metal, between different metals in a coating, and between the coated metal and some other metal with which it may be in contact.

(4) Measuring effects of changes in the nature of the coating on its durability in the test and, ideally, it should be able to relate this to durability under conditions of common use.

(5) Reproducing forms of attack encountered in service, so that they can be studied, and eliminated by changes in the coating.

In conclusion, the author says that so far as the nickel component of a composite coating is

* The Mond Nickel Co. Ltd. (Development and Research Dept).

concerned, thickness and uniformity of thickness are still of primary importance where corrosion-resistance is required, and although double-layer deposits can give additional protection, responsibility for the production of serviceable coatings still lies with the plater and the designer, whose job it is to ensure that optimum mechanical properties, ample thickness and uniformity of coating are consistently characteristic of all the plating produced.

Abstract

RECENT DEVELOPMENTS IN DECORATIVE CHROMIUM PLATING

by S. W. Baier *

AN excellent historic account is given by the author, of decorative chromium plating following the early beliefs in its performance and corrosion resistance. The general behaviour of chromium coatings is now well understood and summarized briefly by saying that very thin coatings are porous and, on exposure, corrosion of the underlying nickel starts at these pores. With slightly thicker chromium the porosity decreases, but beyond a certain thickness the chromium starts to develop cracks and the corrosion resistance deteriorates once more.

For many years it was believed that the main reason for the failure of nickel/chrome plating was porosity in the nickel coatings, so instead of directly investigating how the composite coatings failed during exposure, research was concentrated for a long time on a search for the causes and cure for porosity. However, in 1958, the results of B.N.F. exposure tests, comparing the relative behaviour of chromium plating over dull-nickel and over various types of bright-nickel, were published. In this paper photomicrographs are shown illustrating the way that corrosion pits develop during atmospheric exposure. Briefly nickel corrodes on exposure with a type of pitting attack at a rate which is greatest in the industrial areas where there is a relatively high concentration of sulphur dioxide or sulphuric acid in the air. The corrosion is largely electrolytic, with the bare nickel at the base of any pores or cracks in the chromium overlay acting as anodes, the surrounding chromium acting as the cathode and moisture on the surface, as the electrolyte, With really porous chromium the effective area of cathode for each pore may be reduced and slow down the rate of attack at each to some extent.

Of the accelerated tests for corrosion testing, the author considers the most useful of them is :

(a) sulphur dioxide.
(b) C.A.S.S. (copper accelerated acetic acid/salt spray test).
(c) Corrodkote.

For assessing the quality of chromium overlays the sulphur dioxide test is the most useful of the three tests. Any porosity or cracking of the chromium is shown up in 24 hours or less, as spots or lines of bright green nickel corrosion products, while the protective value of the composite coatings as a whole can be judged by looking for other corrosion products indicating penetration through to the basis metal.

The author gives a useful summary, and comments on, the plating conditions for H.T.H.R. chromium from chromic/sulphuric acid solutions given in a B.N.F. booklet. He goes on to say that it seems more useful to consider both duplex and H.T.H.R. chromium together as a means of improving nickel/chromium plating. The improved corrosion resistance of duplex nickel depends on the tendency for corrosion to spread sideways once it has penetrated through the upper nickel layer and thus slow down penetration to the underlying basis metal. It follows that if this mechanism works successfully under the comparatively porous coating of thin conventional chromium, it should work equally well for slowing down the rate of attack at the few isolated pores or cracks that may be present in H.T.H.R. chromium.

The suggestion is made that it would be unwise to place high hopes on duplex nickel with conventional chromium and expect it to show every benefit in service here, that it has shown in American accelerated and exposure tests. However, as an undercoat to H.T.H.R. chromium, duplex nickel must be at least as good as ordinary bright nickel and some recently published results show that the H.T.H.R. chromium over duplex nickel does in fact give the best protection.

Apart from plain sulphate or mixed sulphate/silicofluoride as alternative catalysts to sulphuric acid, there is no indication from the various researches undertaken that any others would be of special value for H.T.H.R. solutions. All the evidence suggests that all solutions which give bright chromium are bound to give highly stressed deposits and that the only important factor which reduces stress to any extent, and so reduces the tendency for cracking, is an increase in solution temperature.

The author gives an interesting assessment of the protection mechanism of duplex or dual chromium and sandwich chromium. With duplex chromium, the first chromium overlay is essentially a covering layer and should be designed to give as

* The British Non-Ferrous Metals Research Association (Liaison Dept).

good coverage as possible, particularly in the low-current-density areas, while the second layer is essentially a method of thickening up the chromium to a greater extent than is possible with H.T.H.R. chromium without getting a coarse pattern of large cracks. With a network of numerous but very fine cracks, the corrosion taking place at the exposed nickel at their base should be much slower than the rate of attack at a few isolated pores or at a small number of wider cracks.

The mechanism with sandwich chromium is a little simpler. When corrosion penetrates through any pore or crack in the top layer of chromium, it will penetrate through the nickel only as far as the underlay of chromium. At this point it can penetrate no further, although it may spread slowly sideways in the nickel layer. The final overlay should be an H.T.H.R. coating to ensure the minimum number of cracks or pores at which corrosion can start, and the underlayer of chromium should also be as free from pores and cracks as possible to prevent the chance of initial corrosion pits or cracks continuing through to the basis metal. The underlayer of chromium should be smooth but not necessarily bright, since it is covered with bright nickel.

The author concludes by saying, exposure tests both in this country and America have shown that very considerable improvement in the corrosion resistance of nickel/chromium plating can be obtained by using H.T.H.R. chromium, in place of conventional chromium, but the results should not be interpreted to mean that one can economize on the nickel undercoatings. Some accelerated tests have suggested that H.T.H.R. chromium only gives a relatively small improvement but actual exposure tests have shown that the improvement is considerable and always better than that obtained by using duplex nickel with conventional chromium.

DISCUSSION

DR. EDWARDS, opening the discussion, said he would concentrate on two points connected with corrosion resistance, which was the most important of the problems to be faced. The first was the question of bright *versus* dull nickel.

The tendency was for dull nickel to look barely equal to bright nickel after a long period of exposure, but earlier in the tests it was common for bright nickel to look worse than dull, and since the first appearance of corrosion products was the critical stage in the life of the article from this point of view, it was true to say that dull nickel, properly applied, was generally rather better than bright nickel.

Turning to duplex nickel, he said that the relative corrodabilities of different types of nickel was fundamental to the whole question. The mechanism of duplex nickel was like the sacrificing corrosion of the sulphur component of the upper layer of the bright nickel, protecting the lower layer of sulphur-free semi-bright nickel. This occurred, producing characteristic lateral pits in the accelerated tests. It occurred for some outdoor environments but not every time. In a few cases he had seen an apparent advantage which seemed to depend on the reduction of the number of points of attack rather than on the presence of wide and shallow pits instead of narrow and deep pits.

In the exhibition there were a number of small die-castings plated with normal chromium and two thicknesses of H.T.H.R. chromium on bright and duplex nickel, and there seemed to be no difference between them after a year of exposure at Euston. Similar samples at Banbury and Hayling Island showed no difference, although in this case the corrosion was not very far advanced.

Nevertheless, he did not think that anyone would discourage the adoption of duplex nickel, which had advantages.

B.S. Chromium Thickness

DR. H. A. NICHOLSON, referring to Mr. Baier's paper, said that he seemed to imply that there was some difficulty in getting the chromium thickness which the British Standards specification laid down. It was true that the range was rather narrow, and the new processes which he envisaged as being used in future would widen that range, which was a good thing. But there was no inherent difficulty in obtaining the specified thickness of 0.00001 to 0.00002 in. if a little care were exercized. Plating at 120°F. with H.T.H.R. chrome and reasonable control should not offer any difficulty in attaining the required thickness. Perhaps this point was over-stressed, although Mr. Baier was right in giving a warning against the tendency to get low thickness because of reduced temperature. He pointed out the desirability of getting chrome thicknesses for corrosion protection and stressed the factor of protection which chrome gave.

Dr. Nicholson had collected data on corrosion testing by the old salt-spray test, the Corrodkote test and the sulphur dioxide test over quite a period. The implication was that a reasonable deposit of nickel was just as important as a reasonable deposit of chrome, although the chrome had an important effect in giving corrosion resistance.

The condition of the base metal was another factor. He had frequently found failures among samples submitted to corrosion tests with a very good coverage of nickel, whereas samples with rather a poor coverage of nickel but excellent chrome had passed. This had been because of improved base metal compared with poor base metal finish in the previous case.

Mr. Baier had referred to duplex chromium and crack-free chromium as being widely used in the United States. When Dr. Nicholson had been there a year ago, he had not found this to be so.

Turning to the new corrosion test, he said that Mr. Baier implied that duplex nickel was of very doubtful value. When Dr. Nicholson had been in the United States, although the new chromium processes had not yet taken on, there had been universal agreement that the duplex nickel process was an improvement.

He had found from customers' service returns, from motor cars used on the roads, that since using duplex nickel, the number of returns for corrosion breakdown had been markedly reduced.

Early Chromium Plating Practice

Mr. OLLARD (Atlas Plating Works) said that he could remember the very beginning of chromium plating. In those days they had not used an undercoat but had plated a fairly thick covering of chromium, matt. They had mopped it up in the polishing shop, a difficult process, to get a bright finish and had often achieved good corrosion results, but it had not been a commercial proposition because of the very high amount of work involved.

As regards corrosion tests he said that the shape of a crack was a factor in determining the time it took for the diffusion products to diffuse from the bottom to the top and therefore allow further corrosion to take place. If there were a large concentration of corrosion products at the bottom of the crack, he did not think there would be a high rate of corrosion.

The plater was dependent on accelerated tests because it was necessary to find a fairly quick answer. Undoubtedly Dr. Nicholson had an excellent answer ; he plated many articles and sent them out to customers, and then saw how many were returned ! Unfortunately, customers did not always send back articles which failed. As a plater, perhaps he should be thankful for this, but if something were going wrong he preferred to be told about it.

If it was possible to get a continuous coating of chrome over the article, the undercoating might be of much less importance. One point which had been neglected in putting a coating of chrome on nickel, particularly bright nickel, was that many deposits had on their surface an adsorbed layer of addition agent. If addition agent were not adsorbed on the surface, it would not work. It might be that some addition agents were removed by the chromium and some were not, but he had noticed that different bright nickel processes seemed to take chromium in a very different way. When dealing with barrel chrome, which was very unpleasant in this respect, he had found that there was only one process which could be used without giving treatment between the two processes.

Value of H.T.H.R. Chrome Established

MR. J. SPRAGUE suggested that the value of H.T.H.R. chrome had definitely been established and, bearing in mind Dr. Nicholson's remarks about the need to take into account the extra conditions to be met, it was a good process indeed. But it had been shown, using H.T.H.R. some time ago with straightforward bright nickel, that the answer was to give a good background to the coating. The bronze plating undercoating, which had at one time been used widely, was extremely valuable from the corrosion-resistance point of view. He asked if the method was dead for commercial reasons, and invited the authors to comment on the possible value of such a process ?

He suggested that half the test-piece should be properly cleaned and the other half should be left, corresponding to the way articles were often misused in practice.

MR. T. SUCH (W. Canning) said that Mr. Castell had based his argument for duplex nickels on the fact that some nickels were more noble than others and therefore corroded less readily when tested singly. That some nickels were more corrosion resistant than others in such circumstances seemed definite enough, although he was not at all convinced that either the lower sulphur content or the different structures of such nickels were the sole criteria for this improved corrosion resistance.

To get the maximum corrosion resistance from such nickels, his evidence indicated that it was preferable to use them alone without a top coat of bright nickel, even if this meant a " colouring up " operation before chroming. With the obvious production disadvantages in even such light nickel finishing, duplex nickel would often be chosen as a compromise. But it appeared that much of the enhanced corrosion resistance of a more noble nickel was lost when it was incorporated in a duplex nickel, as much as 80 per cent. of the whole.

As Mr. Castell said, the acetic acid-salt spray certainly showed up duplex nickel favourably, but he did not think that this test resembled service conditions in this country more closely than the sulphur-dioxide test. The fact that the benefits of duplex nickel were not so evident in the sulphur-dioxide cabinet were confirmed by service trials. From his own experience, however, he felt that neither test gave the correct picture for duplex nickel.

This was not surprising for what must obviously be very artificial conditions. Duplex nickel appeared to be neither so corrosion resistant in practice as the acetic acid-salt spray indicated nor to show so little advantage as seen in the sulphur-dioxide test. Briefly, the position seemed to be that the more corrosive the conditions, either in an accelerated or an out-door corrosion test, the less benefit was given by duplex nickel. In just the

conditions where conventional nickel would fail quickest, therefore, there would be least improvement by the use of duplex nickel, which meant that it was desirable to cover even duplex nickels by a coat of chromium plate which as far as possible was free from pores or cracks. Nevertheless, the use of nickels which were not fully bright as undercoats gave advantages in other directions with their high levelling and ductility, and he felt that it was these advantages which had led to their adoption rather than any slight gains in corrosion resistance.

Thick Coatings of Crack-free Chromium

He agreed with Mr. Baier that the greatest improvement in corrosion protection in the atmospheric conditions prevailing in this country would be given by using thick coatings of crack-free chromium either over a conventional bright nickel or duplex nickel. Even a small increase in chromium thickness over the 0.00001 in. which was applied, or was supposed to be applied, at present would show a marked benefit, but to avoid excessive cracking at the edges of heavily chromed articles it was necessary to use the special H.T.H.R. type of crack-free chromium referred to by Mr. Baier.

Referring to tests on crack-free chrome he said that after nine months of static roof testing of bright nickelled and chromed steel panels, conventionally chromium plated ones had an A.S.T.M. rating of 2, while those with the 0.00003 in. of crack-free chromium were rated 7.

MR. F. TAYLOR said that in his opinion duplex nickel tended to be inferior to one single coating. If they were dealing with bright nickel on a dull nickel undercoat, there was definitely crazing of the bright nickel and severe corrosion, and with semi-bright nickel it was even worse. It was suggested that when dealing with duplex nickel they might be putting on two coats of paint, but he did not think this was the case ; the trouble could to a large extent be minimized with automatic equipment although on static plant the human element was always a major factor. He had had good results with straight nickel in the past and if as much attention had been paid to dull nickel as to bright nickel, there probably would not have been the need for as much bright nickel as was used today. It was only economics which kept so much bright nickel in existence.

Corrosion tests, although interesting in themselves, were to a large extent only partially valuable, because they could not be tied up with ductility and internal stress. Also, on a bad basis metal the covering power of bright nickel was bad and this could not be overcome by thickness. The more bright nickel they put on, the greater the internal stress. There was also, generally speaking, inferior throwing power. As for chrome coverage on nickel, some of the bright nickels covered remarkably well and some not at all. As the decomposition products built up, this could be magnified, especially in static plants where the time intervals were longer.

Crack-free chrome had great value but it was necessary to strike the happy medium mentioned by Mr. Baier of using a reasonable sulphate ratio and a reasonable chrome concentration in plant without first-class analytical facilities.

MR. M. CLARKE (Tin Research Institute) said there seemed to be a question whether the improvements said to be gained with duplex nickel were due to the slightly different composition of the two nickel layers. Cracks and pores penetrating the top layer were shown in one of Mr. Castell's figures to be spreading laterally instead of going through the second coat. It had always been observed, however, that duplex coats produced in the same bath by interrupting and polishing were also said to perform better than the same thickness applied in one coat. It was therefore probable that there were at least two effects, difference in structure as well as difference in composition.

Intrinsic Porosity of Nickel Coatings

The question of the intrinsic porosity of the nickel coat had rightly been much reduced in status by the attention paid to the cracking and porosity of the chromium coat, but as an old-fashioned "porosity man" he pleaded that this factor should not be disregarded entirely. Working with coats which do not require a chromium top layer, he had in the best of conditions gone as thick as 0.005 in. of a very good coat on steel and still not been able to eradicate the occasional pore which gave rise to rusting.

He wondered whether the industry was in danger of forgetting about the basis metal and its manufacture in order to concentrate on duplex nickel. The odd inclusions and so on could arise even if it gave rise to only one pore, on quite a large surface ; it would still give dissatisfaction to a user. Apparently not much was being done at present to deal with this.

One possibility which he had in mind, although he did not yet know how to try it out, was whether a skin could be put on special plating quality steel of, say, a good electrolytic iron, being finished by rolling to a very high surface finish. It also might be possible to use an undercoat which would lead to the blocking of a pore by its corrosion products. This might be less troublesome than a pore which went right through to the steel and produced unpleasant rust staining.

MR. U. F. MARX (Wilmot-Breeden) said that in many plating communities the polishing was the biggest expense involved. By using a duplex

nickel process, not only could the initial polishing costs be reduced, because some semi-bright solutions had levelling properties, but the subsequent buffing of the nickel could be eliminated entirely.

He was a little doubtful about the value of the comparison made in various corrosion tests. The only test which counted was that suggested by Mr. Nicholson, viz. the number of returns.

MR. BECHTOLD (M. L. Alkan) said that the importance of surface smoothness and continuity applied even more to chromium where the question of inferior covering and throwing power arose. The ideal would be the invention of a process which provided a completely continuous layer of chromium. At best they could improve the covering and throwing power, thereby enabling the plater to put on a thicker deposit which might be crack free up to a certain thickness. He suggested a figure up to 0.0001 in. and over. The value of thicker chrome had been proved and had undoubtedly been responsible for much improved plating. The aim should be to improve the existing chrome process and put on heavier chrome deposits that would not discolour and show inferior chrome blooming.

MR. PROSSER (Ionic Plating Company) said that Mr. Baier had mentioned some simpler conditions in which crack-free qualities could be obtained, and these would be possible without any alteration of plant, presumably, since the temperatures were much lower although the concentrations of chromic acid were somewhat higher. He asked if any research had been done on these conditions which was applicable to production use?

MR. F. WELLS asked Mr. Castell about the inclusion of sulphur in the electrodeposited nickel. In the paper he had mentioned that the sulphur was not included in the electrodeposition from nickel sulphate because the negatively charged sulphate ion did not get through the charged layer at the cathode.

Corrosion tests which he had carried out, showing results from a bright nickel solution containing sulphanate, gave more than adequate A.S.T.M. acceptance. On average, they could multiply the acceptance test by ten before it started to break down.

MR. D. WEIMER said Mr. Baier had made the point that it was possible by increasing the thickness of crack-free chromium to reduce the thickness of duplex nickel. This was not the case. It was essential to have about 0.001 in. bright nickel or duplex nickel underneath a crack-free chromium deposit. It was not possible to reduce the thickness of nickel by increasing the chromium thickness, using a crack-free system.

He agreed with Mr. Baier that the accelerated tests favoured particular systems but did not agree that the Corrodkote test favoured a thinner or porous chrome. In his opinion it was not important that an accelerated test correlated with outdoor exposure. The point of approach was that one determined the plating system by outdoor exposure tests and then used some form of testing procedure to assess the finish that one wanted on an accelerated basis. It did not much matter whether one used nitric acid or Corrodkote or any other system, provided that the deposit gave the correct number of hours under the exposure test.

AUTHOR'S REPLIES

MR. H. C. CASTELL, in reply, said that Dr. Edwards did not believe that bright nickel was inferior to double-layer or dull nickel. He had pointed out in the paper that industrial atmospheres had a much greater effect on all nickel deposits than marine atmospheres. The picture he had shown had been of marine atmosphere exposure, where these differences were much more marked. Dr. Edwards had said that the corrosion mechanism outlined for double-layer nickel deposits did not always occur, but many of the comments in the paper, which had drawn on much work done in the United States, had been confirmed by Mr. Castell's colleagues in the laboratories.

Replying to Mr. Ollard he said a great determining factor was the corrosion of the nickel itself. He thought that the corrosion products came to the top fairly quickly, and they could quickly see when the nickel deposit had been penetrated by corrosion that the nickel had broken down. He had pointed out that service tests were the absolute method of testing and that accelerated tests, while useful for control, were not at the moment satisfactory for predicting service behaviour of a plated part. Much more must be learned about the mechanism in various environments before a test could be designed which would predict service behaviour.

Importance of Continuous Chromium Layer

A continuous chromium layer would be important if it could be achieved, but they were a long way from that. Much work had been done on chromium plating in the past few years but they were still in the state of cracked and not crack-free chromium deposits.

Mr. Sprague had said that present techniques were useful as a stop gap but were not the final answer. Test panels should be cleaned from time to time if only to simulate what happened in service where the owner of plated equipment cleaned it from time to time. In the United States they preferred to do otherwise, probably because cars in that country were not cleaned so regularly. He did not agree with Mr. Sprague's suggestion for two tests, one to break down the chromium

and the other to break down the nickel. It would be better to aim at a simpler test which did not involve expensive apparatus.

Mr. Such had suggested that single-layer deposits had advantages over duplex double-layer deposits and that the sulphur-dioxide test followed service break-down fairly closely, but Mr. Castell's results did not agree. The mechanism was entirely different and he thought that the sulphur-dioxide test gave breakdown results very different from those experienced in service.

Practical Platers' Problems

Mr. Taylor had dealt with practical platers' problems and had said that duplex was inferior to single coating. That was not a view with which Mr. Castell agreed. It was true, however, that the type of nickel deposit and the conditions under which it was laid down were extremely important in respect of ductility and internal stress. He had always been a little doubtful about some American results in that the conditions of deposition were not known—for example, whether an ageing solution or a fresh solution had been used. The mechanical properties of the deposition had been shown to be important some years ago and were still important. This must be borne in mind when comparing one nickel deposit with another.

It was true that the covering power of bright nickel was bad. Dr. Watson had pointed out in his work that concentrations of addition agent could give rise to a reduction in throwing power. It was very necessary to make sure that the recesses carried sufficient thickness to prevent premature breakdown.

Mr. Clarke had made the point that double layers arrived at in two ways could give improvements and therefore there must be a different mechanism. This was probably true, but it must be an electro-chemical mechanism. The effect of polishing might create a condition of passivity on the bottom layer. It was true that porosity could not be entirely eliminated, as he had shown with deposits as thick as 0.005 in. With up-to-date filtration techniques and other new techniques the modern plater would reduce this. But it was still a fact that the greatest factor in the break-down of nickel and chromium deposits was in the chromium rather than the porosity.

He doubted whether duplex steels would be a practical proposition but the blocking of pores by undercoats was very useful and would be followed up.

Importance of Good Throwing Power

Good throwing power for chromium solutions was important and in existing chromium solutions the throwing power was extremely bad. He had measured differences in thickness between thin and thick points on a complicated shape with chromium deposits and had found a ratio of about 100 to one whereas the nickel ratio was ten to one.

Some speakers pointed to a serious problem which faced not only the plating industry but all industry, the need to instal techniques known now rather than to wait for further developments.

In dealing with sulphur in electrodeposits he had quoted work by *Rogers*, *Ware* and *Fellows* giving some conclusive results for the incorporation of sulphur from labelled sulphate and labelled thiourea, and there was a difference between the two values.

MR. BAIER, in reply, said he accepted the practical difficulties ; it sounded pleasant to change from 0.00001 to 0.00003 in. of chromium but this meant possibly doubling the current in the same size of vat, giving a high current density and a high current passing through the jigs. Mr. Such had mentioned another possibility, using concentrated solutions and not quite as high temperature and current density. These were compromises. It was interesting to hear that Dr. Nicholson had found in a number of articles that higher nickel and higher chrome gave the lowest number of rejects. It was not surprising that thin nickel and high chromium was no better than reasonable nickel and thin chromium. He did not know why this was, but he was sure that to get a decent nickel-chromium coating for out-door use it was necessary to bring the nickel up to a specification thickness, 0.0012 in. Subsequently, the nickel could be brought a good deal further, but the amount of improvement was not very great and at that point, improving the chromium, did a lot.

Condition of Basis Metal

He agreed that the condition of the basis metal was important. We were improving our nickel and chromium so much that we were reaching the stage at which the few odd pores left behind might become clearly noticeable, although up to the present the corrosion story had been much more important than the pores in the chromium due to basis metal defects.

Mr. Sprague had asked about the possibility of using bronze plating as an undercoat for chromium. In the early days Mr. Baier said he had done a lot of work in bronze plating, and it had some properties as an undercoat for chromium. The system had nearly come into general use. At the time it had come the closest to a quick process of handling a fairly rough steel, putting on bronze and polishing and putting chromium on top. This had broken down in the cracking of the chromium because the copper corrosive products had come through in a crack pattern in the chromium. He would like to see the system investigated again, but he did not know whether it would work as well as nickel.

(To be concluded)

A Quarterly Survey of some of the Feature in Finishing Literature from Abroad

by SCRUTATOR

IN the electroplating field, the problem of obtaining increased corrosion protection from nickel/chromium plating is still the subject of a considerable amount of work. Recently, Bigge[1] of the Chrysler Corporation has reported the results of outdoor atmospheric exposure tests on nickel/chromium plated zinc-base die-castings and steel parts, with particular reference to automobile finishes and he has confirmed much of the current thinking on duplex coatings. After 1-year's atmospheric exposure at Miami, Detroit and Pittsburgh, buffed Watts nickel or semi-bright nickel coatings followed by bright nickel gave superior performance to bright nickel in the system copper/nickel/chromium on zinc-base die-castings. Further, under the same exposure conditions semi-bright plus bright nickel gave superior performance as compared with bright nickel alone in the nickel/chromium plating of steel both on flat panels and panels bent flat after plating. In an additional series of tests, 18-months' exposure at Kure Beach of nickel and chromium plated panels showed that substantially increasing the thickness of the semi-bright nickel or of the bright nickel when these were used as a single nickel layer did not produce the same performance as that obtained by the use of semi-bright plus bright nickel in multi layer coatings.

In the search for decorative plated coatings of improved durability, a relatively new development is the use of micro-cracked chromium which as the name suggests consists of a chromium deposit with a microscopic system of criss-crossing cracks. Such coatings are now being deposited on an industrial scale and over copper and bright nickel they have been credited with very high corrosion protection. Safranek and Hardy[2] have developed a new laboratory procedure for depositing chromium with this characteristic structure and have reported their work in the hope that it might have some commercial possibilities. In essentials, this consists of the addition of selenic acid in small concentrations to a conventional chromium plated bath. On one set of zinc-base die-cast specimens using 0.8 mil. of bright nickel and 0.55 mil. of the micro-cracked chromium, no basis metal corrosion occurred after 144 hours of copper-accelerated salt-spray testing (Cass test).

Still on the subject of nickel plating, Brook[3] has studied the effect of surface preparation of the base metal on the tensile strength of electrodeposited nickel, during the course of which he developed a new method of measuring such tensile strengths. It was found that adhesion was markedly influenced by surface preparation and mechanically scoured surfaces gave the lowest adhesion. Electropolished surfaces gave some of the highest values.

Paint

Prefinished aluminium strip is finding ever increasing uses in the United States and its applications are not confined to formed and fabricated products as extensive use is now being made of it in the building and constructional industries. Typical outlets include house siding, awnings, shutters, gutters, downspouts, carports, porches, etc. Peek[4] has described the procedures used for the manufacture of Colorweld where 20 different paint colours are available with either the same or a different colour on each side of the strip. There is a 36-in. and an 18-in. line, each 300 ft. in length. Cleaning and chromate surface conversion is carried out on a 5-stage spray pretreatment section followed by a double roller coater and a 5-zone indirect fired gas convection oven. A novel feature of this is the burning of the solvent vapours removed from the oven to provide additional heat. This produces an increased volume of exhaust through the entire oven and also results in the absence of solvent vapours exhausted to air. The exhaust vapours are conducted to a chamber where the temperature is raised by gas from 300°F. to 600°F. The volatiles do not burn until the heated vapour passes over a platinum grid catalyst when ignition raises the temperature to 1200°F. The heated air is then passed back to the oven. This burning of the volatiles from the paint to produce heat for the oven is most ingenuous and is of course specially applicable to continuous strip lines. As another example, one of the world's largest producers of painted aluminium strip is claimed to be the Gnadenhutten, Ohio plant of Alsco Industries[5]. Here, 20 miles of aluminium strip are painted per 24 hours. The plant, which again has a conventional cleaning and conversion

(*Continued in page* 487)

U.S. AIRCRAFT FIRM INSTALLS HARD-COAT ANODIZING PLANT

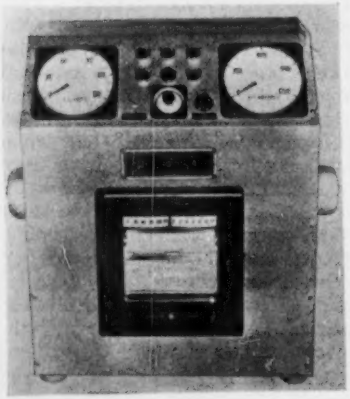
Main Use for Missile Components

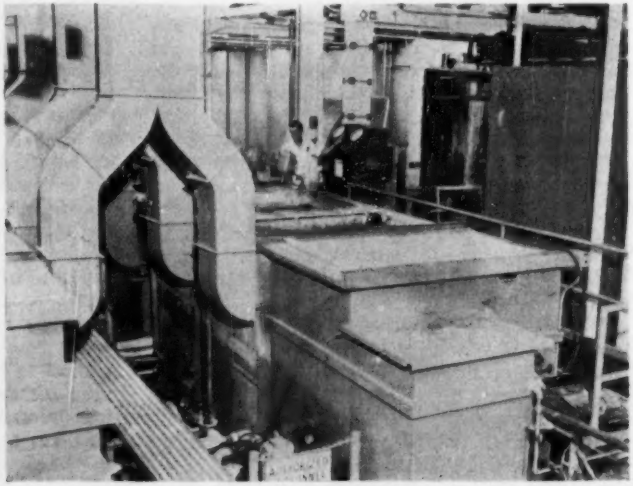
THE Douglas Aircraft Company, U.S.A., has recently installed one of the largest hard coat anodizing installations in the country at the Army-owned, Douglas-operated Charlotte, North Carolina plant, which, occupying 77 acres, is devoted primarily to the manufacture of the Nike Hercules missile, the Army's primary ground-air anti-aircraft weapon.

The heart of the hard anodizing installation, consisting of five process and rinse tanks, is a constant-current, constant-voltage control, automatically controlled 100-volt, 1000-ampere rectifier, designed and built by Hanson-Van Winkle-Munning Company, Matawan, N.J.

Fig. 1 *(below)—Control console of Hanson-Van Winkle-Munning Company rectifier. The console automatically changes current and voltage as work requirements demand. Several automatic alarm and warning devices are included.*

Fig. 2 *(right)—Beginning of the H-VW-M hard-coat anodizing line showing technician making a manual adjustment after lowering work into chilled anodizing tank.*





An example of the work which Douglas successfully processes in this installation is a hydraulic cylinder for the Nike Hercules. Because the missile may be stored for many years before use, and because its components must be periodically tested during storage, the interior of the cylinder must, in addition to presenting a hard wear surface, also be corrosion and crack resistant. Hard-coat anodizing meets these specifications.

Essentially, hard-coat anodizing is a process for creating a relatively thick network of interlocked aluminium-oxide crystals on the surface of aluminium. The hard coat of aluminium oxide is produced by impressing a high current, at relatively low and varying voltage, on to the work to be processed while it is immersed in a low temperature current-conducting solution.

During the process of hard anodizing, the resistance of the aluminium increases as the thickness of the aluminium oxide coating increases. To keep the amount of current on the work surface constant, which is essential in the hard anodizing process, it is necessary to supply increasing voltage to the work. The rectifier current control console accomplished this automatically and during processing the rectifier requires no supervision whatsoever.

The anodizing cycle takes approximately 75 minutes to complete. It is necessary to provide a constant current of 25 amp. per square foot to the hydraulic cylinder for suitable anodizing. At the beginning of this cycle, the voltage requirements to maintain this amperage stand at between 10 and 20 volts. At the end of the cycle, 85-90 volts are necessary to maintain the 25-amp. current density.

(*Continued in page* 487)

U.S. Aircraft Firms Installs Hard-coat Anodizing Plant

(*Continued from page* 486)

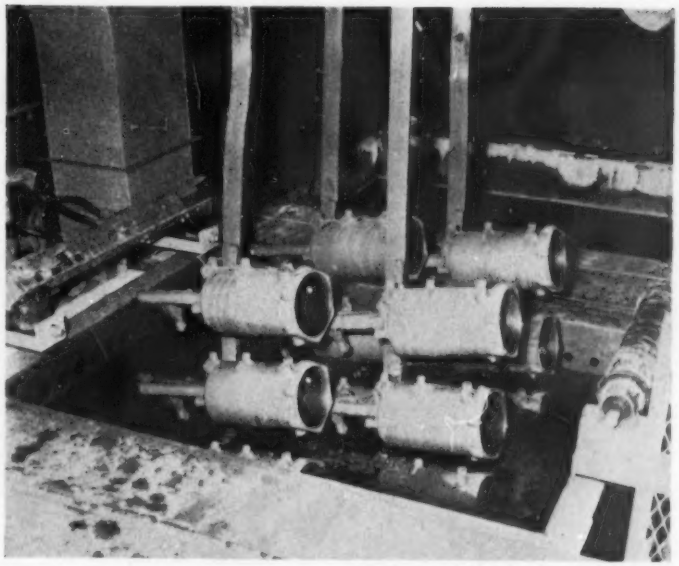


Fig. 3.—Close-up of work being withdrawn from tank after anodizing. Dark exterior of work is a plastic coating which prevents work exterior from being anodized. Solution temperature is about 20°F.

The rectifier control panel includes a recording ammeter and voltmeter to help Douglas record changes in the process and thus achieve maximum control and surface uniformity. Several safety features are included to enable the unit to protect itself against internal and external damage.

Previous to installing the H-VW-M anodizing system and rectifier, Douglas had parts hard-coat anodized by an outside concern. The greater degree of control afforded, coupled with the substantial economies involved prompted purchase of the equipment.

Overseas Review

(*Continued from page* 485)

coating sequence before the application of acrylic paint, is fired by natural gas and the extra heat obtained by burning the paint volatiles is recirculated to the paint stoving oven. After painting, the coils are formed, cut to length and backed with foam for insulation purposes. They estimate that next year the American building trade will use some 700,000 tons of aluminium.

So much for putting paint on. As for getting it off, Pfeffer[6] has published some most useful, practical recommendations based on his experience in setting up a paint stripping installation for the removal of epoxy and acrylic finishes from aluminium, zinc, steel and phenol plastics. An emulsifiable wax was preferred to a liquid seal for reducing evaporation of the proprietary methylene chloride paint stripping solution and the plant installation is described in some detail. It is clear that for optimum results a hot alkali tank " in the corner " is completely inadequate. Paint stripping is a subject on which there is comparatively little published information and this article will well repay study.

Shapes and Forms

Galvanized sheet—either differentially coated or protected on one side only—is receiving considerable attention in the United States for potential use in automobile bodies. Differentially coated material is produced by wiping most of the zinc off one side to give coating weights of 0.60 oz. and 0.10 oz. per sq. ft. on respective sides of the sheet. Nelson[7] reports that galvanized sheet can be formed as readily as uncoated sheet but not with the same tooling. Other news regarding forming and shaping is a description by Faust and Snavely[8] of electroshaping—a new rapid and accurate electrochemical method of metal removal—and a review of the most recent developments in explosive forming and chemical milling[9].

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(2) *Plating*, 1960, **47**, (9), 1027-1031.
(3) *Plating*, 1960, **47**, (11), 1269-1271.
(4) *Ind. Finishing*, 1960, **36**, (127), 40-42, 44, 46.
(5) *Metal Finishing*, 1960, **58**, (11), 58.
(6) *Metal Finishing*, 1960, **58**, (9), 56-59.
(7) *Metal Progress*, 1960, **78**, (5), 93-95.
(8) *Iron Age*, 1960, **186**, (18), 77-81.
(9) *Metal Progress*, 1960, **78**, (3), 112-116.

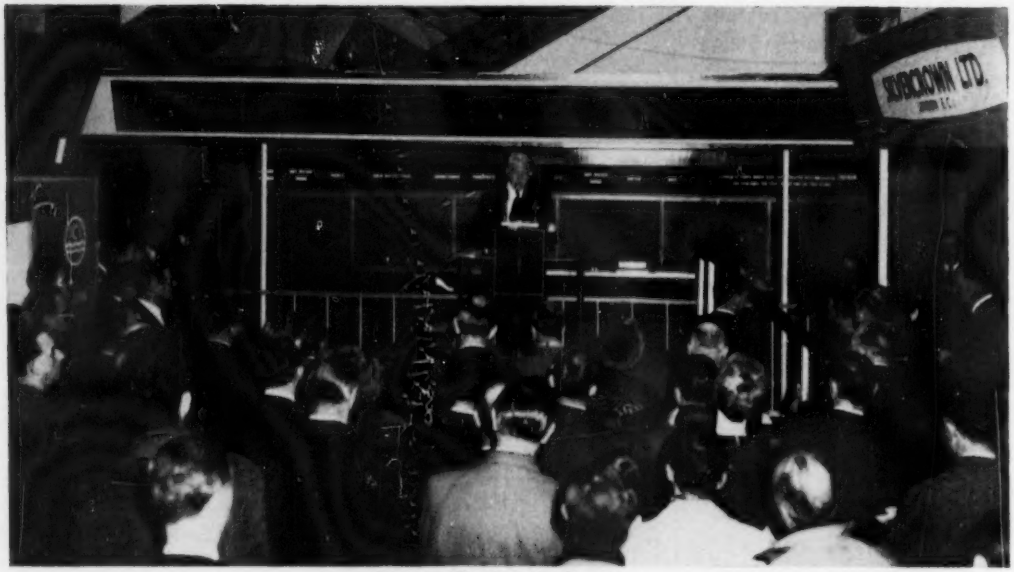

Fig. 1.—The Opening Ceremony

THE CORROSION AND METAL FINISHING EXHIBITION

NOVEMBER 29 to DECEMBER 2, 1960

A Review of Some Metal-Finishing Applications

THE Corrosion and Metal Finishing Exhibition was opened on November 29, by Sir Alexander Fleck, K.B.E., F.R.S., who, in the course of his opening speech, referred to the fact that he was president of the Society of Chemical Industry whose Corrosion Group had cooperated by organizing a technical Symposium during the period of the exhibition. The Plastics Institute had also arranged a symposium, and, Sir Alexander said, the S.C.I. were having a further symposium in April 1961, and this showed the Society's acknowledgement of the importance of the subject of corrosion and the need for its continued examination and discussion.

He then referred to, and showed some of, a collection of iron nails recently discovered at a site in Scotland which was the G.H.Q. of Agricola. The total weight of nails found was 12 tons and the bulk of them were in reasonably good preservation. The nails had not yet been examined, but he hailed them as worthy examples of corrosion-resisting iron that had existed through practically the whole of the Christian Era. Corrosion of metals in modern terminology was accepted as an electrochemical phenomenon, but empirical practices could give useful results when dealing with corrosion problems and the development of some of the stainless steels was quoted as typical.

With regard to metal finishing, Sir Alexander said that there was no doubt that good initial preparation was the firm basis both in the literal as well as the figurative sense, and good chemistry both physical and inorganic was fundamental to practice and precept.

A Review of some of the Exhibits

In the following pages a selection of those exhibits of primarily metal-finishing interest is briefly reviewed.

Pretreatment

Featured in the **Pyrene** display were the company's latest range of treatments for aluminium,

the new Parker finishes P.45B and P.45C, the latest developments in the range of low-temperature immersion " Bonderite " processes and the cold " Bonderite " system. The range of treatments for aluminium has recently been augmented to include three new Bonderizing processes, namely Bonderite 710, Bonderite 701 and Bonderite 740. The cold Bonderite system, introduced in this country in 1958, is now well established and is a " Spra-Bonderizing " treatment. It provides high-quality Bonderite coatings and claims to reduce heating and maintenance costs.

Roto-Finish Ltd. showed a number of their corrosion prevention processes among which were A.S.L., a stain-free drying compound, Grisiron, a range of alkaline metal cleaners, Pertrinol, for combined solvent and mechanical cleaning, Euron, a single operation degreaser, deruster and passivator, Grisament, a compound for simultaneous cleaning and phosphating, Atram, for manganese, zinc and special cold phosphating processes, Purilon for derusting and descaling ferrous parts.

The Walterisation Co. Ltd. had their full range of metal surface treatments on show, including Fasbond for the paint-bonding of steel, Foscote of cold brush-on paint-bonding treatments for rusty steel, zinc and aluminium surfaces. Also to be seen on the stand was Deran a compound for the rust removal and passivation of steel, the Walterisation L. chemical oxidation process for aluminium, Walterblak, a black oxide decorative treatment for steel. Typical industrial products showing the application of these and many other Walterisation processes could be seen.

The main product featured on the stand of **A. Sanderson and Co. Ltd.** was Kingston Kurust Primer, a new anti-corrosive treatment designed for application to rusty surfaces and combining rust neutralization with permanent rust prevention. It reacts with rust, changing it to iron phosphate and binding with it an anti-corrosive film formed of a special plastic, and metallic lead. Kurust is anodic to the metal surface and gives full cathodic protection.

I.C.I. Ltd. (**Paints Division**) showed a full range of I.C.I. metal pretreatments for de-rusting and phosphating of steel by dip and spray application, protective coatings for aluminium and its alloys and phosphate coatings which facilitate the cold deformation of steel. The new technique of fighting corrosion of ferrous metals—the Bostik Endurion process—was featured by **B.B. Chemical Co. Ltd.** at the Exhibition. Bostik Endurion is claimed to be particularly valuable for protecting components and mechanisms which are not easily accessible. It is a process which imparts by immersion a fine-textured, corrosion-resistant finish to ferrous metals. It is a non-toxic chemical after-treatment applied to a zinc base phosphate coating and a range of dyes is available for colouring the work, which is useful for part identification, and inspection. In addition to its protective qualities, it has pronounced lubrication and anti-scuff properties.

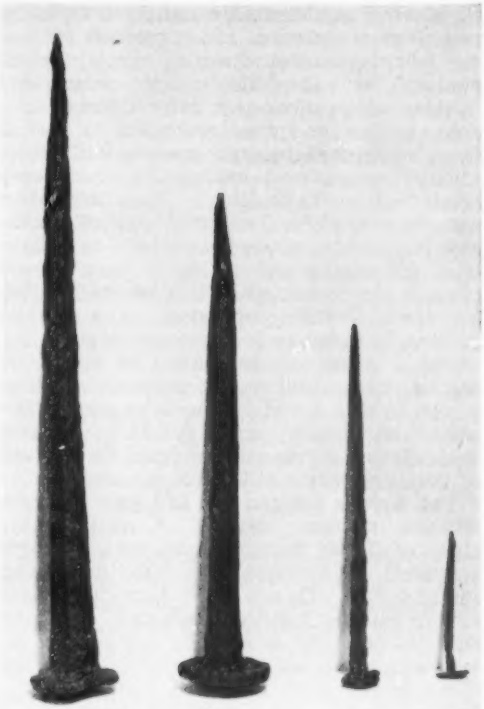

Fig. 2.—Four of the nails, each nearly 1900 years old, found at the site of Roman remains, 12 miles north of Perth.

Vacu-Blast Ltd. exhibited five new machines from their range of mobile dust-free shot-blast equipment. The " Minor," " Midget " and "Dry Honer " machines were available for demonstration throughout the period of the exhibition. The " Majorette " unit has been developed for use on all classes of metal preparation and cleaning and can be supplied in different versions. It can also be used on the " Open Vacu-Blast " system which combines some of the main advantages of the Vacu-Blast system while utilizing certain features of conventional shot-blasting. The " Minor " which has been designed especially for weld cleaning, is compact and has high mobility. The " Midget " is a low air capacity light-duty unit, fully portable, with a wide field of application for small area or " spot " blasting.

The Geigy Co. Ltd. highlighted the importance of quite small amounts of organic chemicals as additives in metal treatment and finishing processes,

all of which are directed essentially towards the prevention of corrosion. Such products fall into the following classes : wetting agents (Belloid products) for acid pickles, alkaline cleaners and finishing compositions such as phosphating solutions, to provide a foaming blanket to prevent fume, to improve drainage, promote level action, emulsify grease, etc.; sequestering or chelating agents (Sequestrene products). These have diverse uses, for example in formulating alkaline cleaners and, in particular, alkaline de-rusters ; as replacement for cyanide and to inhibit trace element effect in electroplating ; and in various finishing and chemical milling operations ; corrosion inhibitors (Sarkosyl and Amine products, benzotriazole). These may be suitable for aqueous or organic systems, and specific to certain metals or general in their action ; de-watering agents (Sarkosyl and Amine products). These improve water-displacing properties of protective oils and of degreasing baths and emulsion cleaners.

The British Oxygen Co. Ltd. gave particular emphasis to flame cleaning. A comprehensive range of Saffire flame cleaning equipment and accessories was displayed on the stand and demonstrations given. On new metal, flame cleaning will remove partially weathered mill scale. On more corroded metal the flame enters and explores the most minute pits and craters, removing solids and dispersing moisture to ensure intimate contact between the first coat of paint and the underlying metal.

Metallic Coatings

In this field the **C and P Development Co. (London) Ltd.** laid particular emphasis on Rust-Anode, a metal coat which can be applied to steel surfaces by brushing, spraying or dipping. It leaves a coat of pure zinc which is claimed to be strongly adherent, ageproof and rustproof. Also on show were Capalla and Skaline. Capalla is a balanced combination of chemicals designed to eliminate and remove rust, atmospheric contaminants, alkali and acid residues, corrosion agents in handmarks and other causes of paint blistering. Skaline is a mill scale remover. It makes a useful pretreatment of metal before applying Rust-Anode, especially where mill scale is prevalent and when sand blasting is impracticable or impossible on standing structures and equipment.

The MacCleaster Chemical Co. Ltd. featured " Dox-Anode," a cementiferous zinc formulation which is resistant to temperatures up to and including 600°C. (1,112°F.) and is said to be excellent as a welding primer ; it will resist abrasion and has a prolonged life. It also possesses good anti-fouling properties and is equally efficient air dried or stove-enamelled, bringing to stove-enamelling shops the possibility of excellent and extremely cheap protection of metals.

Also shown was " Fer-Anode," a compound which can be applied by brush, spraying or dipping, over rusted surfaces or over surfaces which have been previously painted, subject only to some scraping or wire brushing. It is also of above average flexibility, abrasion resistant and although not specifically heat resistant, will withstand a dry temperature of 200°C. and a wet temperature of 120°C. It also possesses good fire retardant properties, prevents " rust creep," is impervious to polluted atmosphere, to sea and fresh water. " Dox," a heavily metallized phosphoric solution, so inhibited that it neutralizes existing oxide and converts it to a good and usable phosphate, was also shown by this firm.

Examples of various iron and steel components rust-proofed by the Sherardizing process and also components protected against heat, corrosion and wear by Arkrom chromium diffusion were shown by **Zinc Alloy Rust-Proofing Co. Ltd.** The Arkrom process was developed by **Metallic Surfaces Research Laboratories Ltd.** who also had a stand, and who specialize in research and development of surface protection methods for metals and engineering materials in general. The laboratories' activities were illustrated by some typical examples of investigations in progress. Included were the protection of metals and alloys against oxidation and corrosion at elevated temperatures, development of Boron-diffusion for wear and abrasion resistance and the effect of corrosion on the embrittlement of ultra-high-tensile steels.

Evode Ltd. were showing examples of practical usage of materials such as aluminium " 308 " a high-temperature heat and corrosion resistant aluminium paint, Bitugel, a heavy-duty thixatropic bitumen solution, and Evotect, the only high gloss anti-corrosive paint that can be applied direct to bitumen without the use of sealer.

Deposited and Sprayed Coatings

The stand of the **Atomic Weapons Research Establishment** illustrated a number of varied techniques that are being applied to the solution of specific corrosion problems in the atomic energy industry.

The protection of uranium, for example, is being tackled by coating the metal with such metals as nickel, zirconium, molybdenum and tungsten by thermal decomposition. Another method of protecting uranium, which is of value in certain circumstances, is the application of certain paints. While a clear varnish actually accelerates the corrosion of uranium, a thin coat of red iron oxide or zinc chromate paint affords effective protection. Isocyanate paints have been developed for the protection of magnesium alloys.

Processes for improving corrosion resistance were featured prominently on the three part stand

of **Albright and Wilson (Mfg.) Ltd.** Kanigen is now well known as the trade name for a chemically deposited nickel phosphorus plate which can be deposited on most metals and on other materials, and is controllable on the most intricate shapes. For bright nickel plating Plusbrite Duplex is arousing much interest, and gives a level, fully bright deposit which is highly ductile. Plusbrite addition agents are claimed not to produce unwanted breakdown products, and are not removed by continuous filtration through carbon. Hagafilm is a non-wettable film which prevents corrosion, improves heat transfer, and thus cuts maintenance costs in condensate systems.

Exhibited on the stand of **R. Cruikshank Ltd.** was the range of bright electroplating processes for both decorative and anti-corrosive purposes. These included copper, nickel, cadmium, brass and silver. Also shown were aluminium components polished in the Minbrite chemical polishing process, and brass components polished in the Polybrite electropolishing process. The non-electrolytic anti-corrosive range of treatments includes the Iridite and Pennsalt processes, which are manufactured and marketed under licence. The Iridite range of processes covers chromate finishes on zinc, copper, cadmium and silver for a variety of applications from purely decorative to anti-tarnish, pre-paint and dyed anti-corrosive finishes. The Pennsalt processes exhibited included special purpose metal cleaning and phosphating for various applications including pre-paint, pre-plating, deep drawing and metal derusting.

The fully motorized TIB Unit (totally immersed plating barrel) was demonstrated on the stand of **Silvercrown Ltd.,** showing the high capacity and simple construction, occupying minimum space. The TIB Unit offers most of the advantages of the more elaborate Tibmatic equipment and is easily operated by one man. This self-contained plating, rinsing, load/unload unit can be extended to a complete processing line by the addition of further stages. Illustrations of the latest semi-automatic copper, nickel and chromium plants were also shown. Examples of the Supersonic and Superbrite range of rapid and bright electroplating processes were displayed and a special feature was the bright hard gold processes and special gold plating equipment. Of special interest was a hydraulically operated pit prop, the ram of which had been plated with the "K" type Nickelex electrodeposit which after exhaustive tests was found to be the only practicable electrodeposit which will withstand the range of corrosive and mechanical conditions required in mines.

The exhibit of the **Tin Research Institute** was tin-nickel plate, the only new electrodeposited coating to have been developed in recent years. This interesting electrodeposit is remarkably resistant to acids and alkalis. The colour tone inclines towards the red end of the spectrum so tin-nickel plated articles have a warm appearance rather than a cold bluish tone. Many electroplaters in the United Kingdom are now equipped and are regularly applying tin-nickel electroplate for scientific instruments, watches, drawing instruments, cooking utensils, and for dies and moulds used in industry.

Metallization Ltd., who introduced the process of metal spraying into Great Britain demonstrated this valuable form of corrosion protection on their stand. Zinc and aluminium are the major coatings applied by this method but examples of sprayed lead, cadmium, copper and nickel could be seen. These deposits, however, need polishing and their use is confined mainly to building up and resurfacing components, for example pump spindles which are ground to size. Excellent results are obtained by spraying ceramic rods and these could also be seen on the company's stand.

Paints

The main products featured on the stand of the **Shell Chemical Co. Ltd.** was a range of " Epikote " resins which are finding applications for marine and structural engineering protection. Also featured were the comprehensive range of high-grade Shell Chemical solvents of particular interest to manufacturers of anti-corrosive paints and metal finishes.

There were two interesting exhibits on the **Aerograph-DeVilbiss** stand ; one was the new airless spray painting unit which eliminates fog from spraying and enables factory and other building interiors, roof trusses, boiler basements, ship holds, tanks and similar enclosed spaces to be spray painted without difficulty. The other was a spraying plant produced to apply urethane foam. The operation is able to control the thickness of the foam which is formed by the chemical action of the material as it leaves the spray gun.

Griffiths Bros. and Co. (London) Ltd. devoted their exhibit to the development of new techniques in metal protection with types of their Ferrodor micaceous iron-oxide-based painting system as the basis. A series of 32 panels, grouped according to their treatments, illustrated the effect of varied periods of exposure to salt spray and high humidity.

The exhibits of **International Paints Ltd.** showed the wide range of corrosion problems which concern the surface coating manufacturer, and the techniques and materials used to overcome them. Panels showed the different effects of weathering, wire brushing, shot blasting, and the use of shop primers on freshly shotblasted plate. Many conventional and modern high-performance coatings, such as vinyl, epoxide and polyurethane

coatings were on view, and special attention was given to the advantages in time and labour of mastic or thick coatings. A model of a Turtle test immersion raft was one of the central exhibits.

Drynamels Ltd. stand illustrated the company's comprehensive service to industry as paint manufacturers and corrosion prevention specialists. Typical proven systems were shown and included primers for all metal and other surfaces, and finishing paints to withstand extreme conditions of weathering, heat or chemical attack. Acrylic stoving enamels provide effective single-coat finishes for domestic equipment and other metal products, having superb adhesion, hardness, colour retention and chemical resistance. Recent developments in the company's specialized coatings include high-build coatings, with exceptional resistance to corrosion, chemicals and abrasion, based on epoxy, coal-tar, neoprene, hypalon, etc. Primers designed for use with such coatings on imperfect surfaces and recent developments in Drygalv zinc-rich paints were also shown.

Main features on the stand of **Hangers Paints Ltd.** were centred round the protection of steel and concrete using the company's epoxide paint systems as well as other specialized and conventional coatings. Particular attention was paid to the underwater protection of ships with the Hangers anti-corrosive epoxide systems chosen by the Pacific and Orient Lines for use on their two new liners " Oriana " and " Canberra."

British Paints Ltd., displayed a comprehensive cross-section of their products in this particular field. Panels showing a complete build-up of specifications designed to deal with a variety of problems were on show, including heat exchangers, calorifiers, steam boilers, internal corrosion in oil tankers, external corrosion of ships' hulls—above and below the waterline, heavy duty coatings and many others. The priming of metal surfaces by means of specialized coating such as cold galvanizing was also shown and the use of polyurethane enamel in the renovation of baths. Interesting exhibits included a steel chimney section demonstrating the properties of heat-resisting silicones as compared with standard stack black, and a tank displaying the efficacy of Epilux 4 as an anti-corrosive for wine, in addition to its more orthodox uses.

The Copon Division of **E. Wood Ltd.** manufactures a range of Copon (epoxy resin) coatings which can be applied to steel and concrete and other surfaces to afford protection against aggressive corrosion conditions whether atmospheric or immersion. These coatings are hardened by polyamide or amine curing agents at ambient temperatures. Stoving Copon coatings were also shown. Sample panels which had been under test for months were displayed on the stand, together with examples of internal pipe-coating which have been in service.

The exhibit of **Alexander, Fergusson & Co. Ltd.** featured pigmented polyurethane systems. Lengths of steel tubing were shown and each specimen demonstrated the system's performance in a particular corrosive environment thus illustrating not only the resistant qualities of the product but its wide range of applications in industry. The company's resources in lead-based materials and in metallic lead are particularly extensive and the use of red lead was illustrated as well as the most recent development in this class. The company's Phalanx calcium plumbate paint has been in use for a number of years now and its effectiveness, especially in marine atmospheres, is striking. A spray cabinet was operating on the stand to highlight this application. The stand also demonstrated the company's recent work in Epikote-based primers and water-thinned primers together with some better known materials in which the company deals extensively, such as zinc chromate primers, zinc-rich paints and etch primers.

Spelthorne metallic lead pigment is used as an ingredient in the manufacture of paints, plastics, rubber and grease, and could be seen on the stand of **Spelthorne Metals Ltd.** As an active ingredient in priming paints for iron and steel it gives a high level of protection that is imparted by priming paints into which it has been incorporated. These paints have proved themselves valuable for protecting ships, bridges and chemical works. To suit the environment Spelthorne lead may be incorporated into a wide variety of paint types, as for example, those based on oil, varnish, chlorinated rubber, synthetic rubber and epoxy resin.

Plastic and Rubber Coatings

BTR Industries Ltd. were showing the latest addition to their "Synco" range of corrosion-resistant materials. An interesting feature of this PVC coating is its wide potential application in the chemical industry, its resistant properties range from alkalis to oxidizing acids, from fatty acids and esters to petroleum hydrocarbons and alcohols. It can be used on structural steelwork and factory plant, as floor coverings for workshops and industrial premises, for protecting concrete, brickwork, iron and non-ferrous metals. Other exhibits included linings and coverings of soft and hard natural and synthetic rubbers ; PVC and PTFE ; sprayed or brush coatings of PVC, Neoprene, Hypalon and epoxy resins.

For over a quarter of a century **Redferns (Bredbury) Ltd.** have been lining and covering vessels and pipelines for the chemical and allied industries which have proved satisfactory against corrosive action. The materials used are natural rubber, ebonite and also synthetics which include

neoprene, butyl and Hypalon. Exhibits included lined mild-steel tanks, pipes and fittings which have been coated with one or other of the materials already mentioned. The company also provides a service in supplying resin-glass fabrications, resin lining steel tanks.

An interesting feature of the stand of the **Dexine Rubber Co. Ltd.** was the special display of corrosion- and abrasion-resistant linings. These included natural and synthetic rubbers, ebonite and a soft rubber lining for use with sodium hypochlorite and chlorinated liquors. This lining has been used successfully for transport and process vessels for some years and has overcome the old hazard of cracking, which was a major cause of trouble with hard rubber linings.

Specimens of rubber lining, both natural and synthetic were displayed on the stand of **Nordac Ltd.,** in the form of rubber-lined pipes, tanks and other items of chemical plant. A demonstration of rubber lining small items such as valves, fittings, and castings formed part of the exhibit. Chemical lead lining was displayed on the stand and a skilled plumber was in attendance demonstrating the technique of lead lining items of equipment used in the chemical industry.

Dorman Long has added plastic-coated steel sheets for industrial buildings to its wide range of steel and chemical products. The new product has been developed in association with **G. A. Willis Ltd.,** who supply the coating as a means of overcoming the corrosion inevitable where steel sheets are used for cladding industrial buildings often situated in districts subject to considerable atmospheric pollution. The coatings of the sheets is completely resistant to caustic soda solution, ammonia, xylol, toluol, benzene, naphtha, mineral spirits, 25 per cent detergent solution, soap solution, 50 per cent sulphuric acid solution and concentrated hydrochloric acid solution.

The **Croda** exhibit featured a cross-section of the company's range of rust preventives and paints, the main accent being on cold applied and hot-dip strippable plastic coatings, de-watering rust preventives and rust removers. Since the last corrosion exhibition the company have developed Promex a cold applied strippable coating and have also introduced a new improved rust remover which will de-rust even though they may be covered with grease or oil.

A comprehensive range of plastic finishes was displayed on the stand of **The Plasinter Co. Ltd.,** and included PVC, nylon, polythene, CAB, PTFE, PTFCE, CPE and epoxide Plasinter coatings. Particular attention was drawn to recently developed PVC sprayed finishes which provide a tough decorative coating of high abrasion, electrical and corrosion resistance. The scope of this material is virtually unlimited.

Plastic spraying and dipping of articles in sizes up to 17 ft. by 7 ft. and up to 5 tons in weight were demonstrated by **Plastic Coating Ltd.** Exhibits included coatings of PVC, polythene, nylon, PTFE, PTFCE and neoprene.

Plastic fabrications and piping installations in PVC and polythene for corrosive fume extraction, tank linings, effluent treatment schemes, scrubbing, towers, etc. were shown by **Prodorite Ltd.** Also shown were Orglas resin/glass laminates which have outstanding strength/weight ratio and are resistant to practically all oxidizing and non-oxidizing acids, alkalis and solvents up to temperatures of 120°C.

Hercules Powder Co. Ltd. devoted the whole of the exhibit to its new thermoplastic, Penton. This plastic is a chlorinated polyether of high molecular weight, crystalline in character and resistant to thermal degradation at high temperatures. It is claimed to possess a unique combination of mechanical, electrical and chemical resistant properties and can be moulded in conventional injection and extrusion equipment. Its most outstanding property is its good chemical resistance at elevated temperatures up to 200 to 220° F. At these temperatures it retains its mechanical strengths and combines with this, surprisingly low creep rates at high pressures. It is also said to have low water absorbtion good abrasion resistance and its outdoor weathering properties are claimed to be excellent. Metal parts can be coated with Penton by spraying, dipping or whirl-sintering. It is available in sheet form for lining chemical tanks and in standard rod and tube form for machining and fabrication.

Protective Rubber Coatings (Bristol) Ltd., have developed a range of liquid-applied self-curing synthetic rubbers under the trade name of Limpetite and this formed the major exhibit on their stand. They have concentrated on applications where non-permeability, high bond strength and resistance to abrasion and chemical attack are all of prime importance. The company specialize in the application of protective coatings either *in situ* or at their works in a number of fields namely for power stations and marine applications. In the general engineering field their coatings can be used on fume ducting, fans, storage tanks, valves, pump casings and impellors for corrosive fluids.

The stand of the **Dunlop Rubber Co. Ltd.,** had been arranged jointly with **Semtex Ltd.,** an associate company and covered the protection of chemical equipment and structures with natural and synthetic rubber materials, the use of polypropylene rubber laminate and chemical brick linings. Specimens of the various types of rubber were shown, together with an indication of their specific virtues in these fileds.

when
top
brass
calls
for
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let

Plusbrite finish what **PHOSBRITE** began

Incomparably the fastest and most economical way to put a fully bright nickel-plate finish on brass is to team up PHOSBRITE 183 and PLUSBRITE nickel. PHOSBRITE 183 chemically polishes brass quickly—even the most intricate shapes—providing a level surface which does not require further mechanical polishing.
In the plating bath PLUSBRITE nickel addition agents provide a good colour, fully bright, highly ductile level finish at a low cost.
The PHOSBRITE-PLUSBRITE process has typical applications in instrument bezels, torch-switches, gaslighters, refrigerator trim, items for the kitchen and T.V. aerials. It offers cost savings and steadier production where brass has to be nickel-plated in large quantities.

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FINISHING

NEWS REVIEW

GOLD PLATED CARS AT THE MOTOR SHOW

ONE of the most striking features of the Motor Show recently held at Earls Court was the display of two motor cars, an Anglia and a Zodiac, by the Ford Motor Co., labelled "His" and "Hers" both of which had been completely gold plated by the Harris Plating Works Ltd., of 18, New Wharf Road, London, N.1.

The Harris Plating Works Ltd. have been using gold as a plating medium since its foundation in 1898 and during its 62 years of operation have produced many interesting and complex examples of decorative plating. The gold plating of the many components on motor cars called for the exercise of its full technical and practical resources, particularly bearing in mind that a quotation was required by the Ford Motor Co. within 72 hours and the operation involved the plating of something like 550 parts of almost every conceivable size and shape manufactured from a wide range of materials including aluminium, stainless steel, Mazak, brass and steel. No drawings or detailed specifications were given and it was necessary to base the costing on an Anglia which a member of the staff had parked outside the factory and a Zodiac borrowed from a neighbouring organization and the plant engineer's plans for specialized equipment required—problems which entailed many hours of exacting engineering constructional work.

The plating operations commenced 7 days from the receipt of the initial enquiry when parts started to arrive from the numerous sub-contractors. These parts had to be recorded and classified in such a fashion that they could be returned to the contractor for final assembly before being passed to the Ford Co. for assembly to the vehicles.

The several materials used for the components called for different techniques to ensure a uniform finished appearance. While the smaller parts could be processed in the standard plant of the precious-metals division, it was necessary to construct a special vat to accommodate the larger components such as the window frames and bumper bars. Extreme care was necessary in handling the components to ensure a blemish-free finish as well as to avoid damage to the soft gold plating and the final polishing operation could only be carried out by the firm's most skilled operators. A special section of the packaging department was allocated to the job and the whole process of inspection and packing was carried out by the most experienced of the packing staff who were required to wear white gloves throughout their tour of duty.

After assembly of the components by the manufacturers, they were forwarded to the Ford works at Dagenham, Essex, and the final exhibits which attracted so much attention at the Earls Court Exhibition gave great credit not only to the high skill in which the polishing itself was carried out, but also to the manner in which cars were finally assembled.

TITANIUM HOOKS FOR NICKEL PLATING

OVER and above its well-established use for steam heating coils, I.C.I. titanium is now making another important contribution to efficient and economic nickel plating —the provision of "non-consumable" hooks for supporting nickel anodes. The cost of anode hooks represents a sizeable factor in the economics of nickel plating; their weight (between 4 and 8 oz.) is added in with that of the anode, so that they are paid for at virgin metal prices. Once used, they cannot be relied on for further satisfactory service, and the most the user can hope for is to recover the scrap value of the metal. The difference between buying and selling price corresponds to a loss of at least 1s. a hook.

In addition, the plating solution which dissolves the anode has a similar effect on a hook of the same metal and some form of protective sheathing of the hook is necessary; it is also usual to work with the hook, and often the top inch or so of the anode too, above the surface of the solution, causing not only technical disadvantages, but resulting in the anode not being used completely.

Hooks made of titanium are so impervious to attack by nickel plating solutions that they can be used as permanent fixtures—they are screwed into the anode in the normal way and transferred from each finished anode to the next one. Titanium hooks installed early in 1958 are still in service. Apart from wear on the thread, which does not affect performance, they are in perfect condition and are expected to last at least as long again. Titanium is completely resistant to all commonly-used dull and bright nickel plating solutions. Consequently, the hook can be taken right down into the solution, and the whole surface of the anode is in contact with the plating solution.

Laboratory tests over many months by a manufacturer of nickel anodes show that there is no preferential dissolution of the nickel near the thread. This confirms the experience of platers, who find that fully immersed anodes wear more evenly and can be used more completely. In practice, therefore, the reduction in anode cost is considerably more than 1s. per operation.

INCO'S THOMPSON PROJECT NEARS COMPLETION

IN a letter to the shareholders, furnishing a pamphlet on the new nickel project at Thompson, Manitoba, begun in December, 1956, Mr. Wingate, chairman of the board of directors of the International Nickel Company of Canada, Ltd., stated that the completion of the new power station and the consequent availability of electricity to the new town of Thompson permits preparatory operations in the mine and plants already completed. Commercial production of nickel will begin early in 1961 and in accordance with plans developed when the project was announced, production at the rate of at least 75,000,000 pounds of refined nickel per year will be attained shortly afterwards; this will raise Inco's total production capacity to more than 385 million pounds per year. Thompson will be the second largest nickel-producing operation in the world and its additional output will ensure a continuing adequate supply of nickel.

The power plant is being built and operated by The Manitoba Hydro-Electric Board and is located at Grand Rapid on the Nelson River.

ADVANCED METHOD OF COPPER-COATING WIRE

AS a result of three-years, research, John Pring and Son Ltd., of Sandbach and Crewe, have developed advanced methods for the copper-coating of wire which claim to provide a new standard in quality plating finish. The plant, which is installed at Elworth Wire Mills, Sandbach, operates on a versatile system which allows any stage of the process to be omitted in order to vary the finished product.

The full process consists of: in-line annealing, cooling or quenching, acid pickle and rinse, repeat acid pickle and rinse, copper coat and rinse, repeat copper and rinse, draw and re-coil on horizontal type machines.

Commencing with rod or wire, sizes between 6 g. and 12 g. can be obtained, finished hard, inter-annealed, wet drawn or coppered with medium or light coat. Water quenching and patenting spring wire can also be carried out before the finishing process.

Being continuous, the process eliminates all handling from rod to finished wire. Eventually, it will be chemically and mechanically controlled to ensure a perfect finish over the whole surface of each strand of wire. Electronic interlocking controls will also be introduced at a later date enabling the plant to produce hard or soft cut lengths (6 g.-12 g.) up to 10 ft. in the various finishes. However, until the plant has been extended, production is limited and enquiries are being dealt with in strict rotation.

In developing this new plant, John Pring and Son Ltd., have received technical information and advice from Imperial Chemical Industries Ltd., on the "Cuprodine" process, which greatly facilitates the successful control of the coating, ensuring consistent results. The Lancashire Steel Manufacturing Co. Ltd., have also co-operated to the full by supplying rimming steel of a consistently high quality which ensures a perfect surface finish.

Plant for copper-coating wire at John Pring and Sons, Sandbach.

INSTITUTE OF PHYSICS AND PHYSICAL SOCIETY AWARDS

THE Council of The Institute of Physics and The Physical Society which recently amalgamated has made the following awards : The Duddell Medal to Dr. J. B. Adams, the Director-General of C.E.R.N. (the European Organisation for Nuclear Research), for his leadership of that team, the Charles Vernon Boys Prize to Professor A. W. Merrison of the University of Liverpool for his distinguished research in experimental physics and the Charles Chree Medal and Prize to Dr. S. E. Forbush of the Carnegie Institution of Washington for his distinguished work on the cosmic radiation.

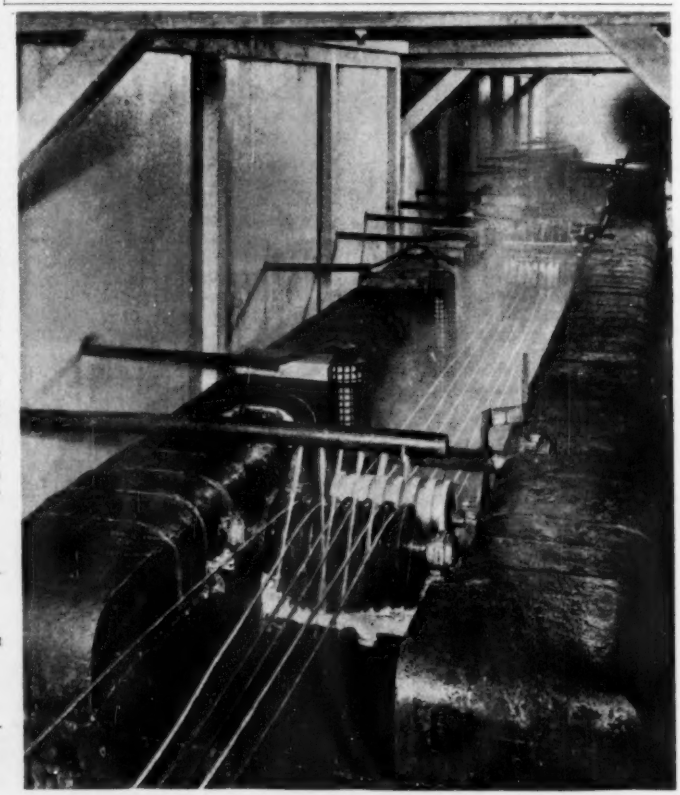
The council have also appointed Dr. D. Shoenberg of the Royal Society Mond Laboratory, Cambridge, as Guthrie lecturer for 1961 and Dr. H. H. Hopkins of the Imperial College of Science and Technology to deliver the Thomas Young Oration in 1961.

ACETIC ACID PRICE REDUCTION

THE Distillers Co. Ltd., Chemical Division, have revised the price of all grades of acetic acid and selling prices are now based exclusively on the size of delivery and the previous basis of calculating prices on contract quantities have been abolished. The revised prices give an overall reduction of about 7½ per cent for all grades.

CHANGE OF NAME

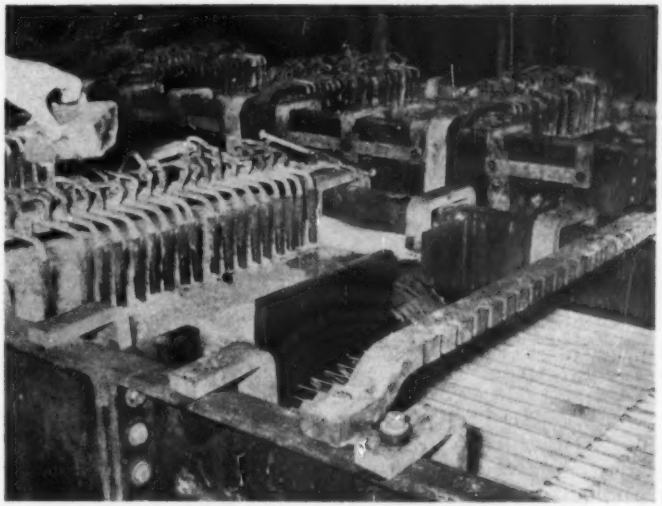
FROM Monday, January 2, 1961, Wakefield-Dick Industrial Oils Ltd., a member of the Castrol Group, is to be renamed Castrol Industrial Ltd. This company is the Castrol Group's United Kingdom marketing organisation for industrial, marine and electrical oils and was known as W. B. Dick and Co. Ltd. before it was reconstituted in 1956. This further change follows logically upon that of the parent company from C. C. Wakefield and Co. Ltd. to Castrol Ltd. last August.



PLYWOOD BAFFLE BOARD NOW IN USE IN HOT ACID BATHS

Claimed Superiority over other Materials

THE superior efficiency of chemically-treated plywood over other materials for covers and baffle boards of galvanizing equipment has been demonstrated by Rylands Bros. Ltd. of Warrington, manufacturers of galvanized steel wire, who are using it extensively in galvanizing equipment in which it is exposed to near boiling solutions of sulphuric acid, zinc sulphate and similar highly corrosive chemicals and has proved a cheap and durable substitute for other materials used by the company in the past, including teak and ebonite. The plywood used by Rylands is Permaply, a resin-impregnated plywood, made by Venesta Plywood Ltd. Permaply was first used by Rylands for covering tanks holding zinc sulphate solutions at temperatures of between 140° and 200° F. The covers previously used were made by two thicknesses of tongued and grooved solid timber but the wood perished and flaked after a few months' use ; the flakes dropped into the solution, and the equipment had to be shut down for cleaning as the pipes became choked. The covers were replaced by covers made from single sheets of Permaply ¾ in. thick some of which have been in use for several years without showing signs of trouble ; the success of this experiment led to the use of 1-in. Permaply in galvanizing or plating cells, where it was put in direct contact with hot sulphuric acid, a 14 per cent solution held continuously at 140° to 170°F. Ebonite sheeting formerly used in the baths quickly softened and buckled and, like other materials tried, was expensive to replace, whereas chemically-treated plywood was found to survive a minimum of 6 months in contact with the acid before needing renewal.



TREATED PLYWOOD FOR HOT ACID BATHS

"PERMAPLY" a chemically-treated plywood made by Venesta Plywood Ltd., is being used by Rylands Brothers of Warrington, to form baffle boards in galvanizing cells. The 1-in. thick plywood seen in the middle of the photograph has proved capable of withstanding the hot sulphuric acid solution in the cells for at least 6 months without serious deterioration.

P.V.C. FUME EXTRACTION PIPEWORK

OUR attention has been drawn to the fact that a substantial part of the ductwork at the refineries at Royston, both in unplasticized P.V.C., in high density Ziegler polythene and in "Tufplas," a patented bonded combination of unplasticized P.V.C. and polyester resin glass-fibre, was installed by Tough Plastics Ltd. of Byfleet Road, Addlestone, Surrey, under their old name of Cawley Plastics Ltd. as well as their current name. "Tufplas" is produced by Tough Plastics Ltd.

FILM: ION EXCHANGE

THE Permutit Co. Ltd., Permutit House, Gunnersbury Avenue, London, W.4, have recently completed the production of a 16-mm. instructional film in sound and colour dealing with Ion Exchange. This is the first film of its kind to be produced in this country and is available on free loan to technical schools, industrial associations, etc. by application direct to the Permutit Company.

The film opens with a rapid survey of the uses of ion exchange in industry and research. Then, with the use of molecular models, the structure of ion-exchange resins is examined. Two of the most frequently used types—the strong acid cation exchanger and the strong base anion exchanger—are shown: models illustrate the incorporation of the active groups into the polystyrene network, and the inter-relation of the fixed and mobile ions with the resin skeleton.

A description is then given of the three major principles on which all ion-exchange applications are based—those of separation, substitution and removal of ions. Three typical laboratory experiments are shown, advantage being taken of the ability of the camera to speed up movement so that an experiment occupying many hours can be observed in a few seconds. Separation is illustrated by the use of two coloured organic ions, one of which is held by the resin while the other passes through. The conversion of potassium permanganate solution to potassium dichromate is used to illustrate the process of substitution, while removal is shown by demineralizing a copper dichromate solution.

This last process is then considered in greater detail in order to explain the basis of the ion-exchange technique. Animated diagrams are used alternatively with column experiments to show what is happening both in solution and inside the resin beads.

The principles of two-bed and mixed-bed demineralizing are illustrated, both in the laboratory and on industrial scale, and examples are given of the uses of demineralized water in industry.

The film runs for 27 minutes.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

Mr. T. J. Kearney, who has been technical sales representative for **Aerostyle Ltd.**, at its Glasgow office for the past few years, has been transferred to the Midland area, and Mr. Alan Campbell has been appointed technical sales representative for Lancashire and Cheshire. Both Mr. Kearney and Mr. Campbell will be representing Aerostyle Ltd. for its full range of finishing equipment and materials.

* * *

Mr. E. Holdsworth has been appointed Northern sales representative for Epok surface coating resins, manufactured by **British Resin Products Ltd.**, and will operate from the BRP office in Altrincham, Manchester. Mr. W. A. Wood, formerly the Northern representative for Epok resins, has been transferred to London and the South of England, where he joins Mr. S. Hodgson and replaces Mr. A. H. Fletcher. Mr. R. H. French continues as Midlands representative, operating from Birmingham.

* * *

Mr. Glen M. Herring has been appointed to the position of assistant sales manager to the **Hanson-Van Winkle-Munning Co.** of Church Street, Matawan, New Jersey, U.S.A. This supersedes his appointment earlier this year as assistant to the vice-president, sales.

* * *

The Minister for Science (Lord Hailsham) has appointed Mr. Frank Cousins, general secretary of the Transport and General Workers Union, to be a member of the **Council for Scientific and Industrial Research** in succession to Mr. H. Douglass, general secretary of the Iron and Steel Trades Confederation, who has retired from the council on the completion of his term of service.

* * *

Mr. H. A. Barratt, chief engineer of **Wallace and Tiernan Ltd.** of Chiswick, the well known chemical engineering company, has been appointed to the board of **E.C.D. Ltd.**, Tonbridge, Kent, a subsidiary company specializing in pumping and air conditioning equipment. The major part of the Chiswick works has been transferred to a new factory at Tonbridge and further expansions are now under way. Mr. Barratt still retains his post of chief engineer and will be largely concerned with supervising future expansions at Tonbridge.

Mr. E. Holdsworth

Mr. W. A. Wood

At the sixteenth annual general meeting of the **Society of British Paint Manufacturers Ltd.** of Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1, held at the Dorchester Hotel, London, on November 8, Mr. T. S. Dally and Mr. B. J. Nicholson were re-appointed president and vice-president respectively for the year 1960/1961 and Mr. W. J. Vines was appointed vice-president in place of Mr. C. A. F. Hastilow who had retired from the council. The four vacancies on the council were filled by Mr. P. F. Jones of Docker Bros., Mr. F. Leigh-Bramwell of W. and J. Leigh Ltd., Mr. C. R. Preston of International Paints Ltd. and Mr. W. J. Vines of Berger, Jenson and Nicholson Ltd. Mr. F. A. Bignell was re-appointed honorary treasurer and Lithgow, Nelson and Co. were re-appointed auditors.

Mr. J. Faulds has become technical sales representative for **Kelvin Hughes** products in North and North-Eastern England, including the counties of Northumberland, Durham, Cumberland, Westmorland, North Riding of Yorkshire and Barrow-in-Furness. His address will be 110, Claremont Road, Whitley Bay, Northumberland.

* * *

Mr. A. E. Richards has been appointed managing director of **Universal Matthey Products Ltd.**, the joint subsidiary company of Universal Oil Products Company and Johnson, Matthey and Co., Ltd., formed in 1953 to meet the needs of the petroleum and petrochemical industries for catalysts.

INDUSTRIAL SPRAY EQUIPMENT FOR GARAGES.

FOR the first time, Atlas Copco (Great Britain) Ltd., compressed air engineers, of Hemel Hempstead, Herts., are to sell their compressors, paint-spraying equipment and air tools to garages and service stations through motor factors, and have increased their sales force for this purpose. British vehicle manufacturers who are already big users of Atlas Copco products, include Vauxhall (compressors), Jaguar (paint-spraying equipment), Rolls Royce (tools, hoists and compressors), Ford (hoists) and Massey-Ferguson (hoists and tools). Equipment can be delivered from stock at Hemel Hempstead and arrangements are also being made for stocks to be held at the company's branches at London, Cardiff, Bristol, Walsall, Leeds, Manchester, Newcastle, Glasgow, Belfast and Dublin.

NEW STORE FOR PAINT MANUFACTURERS AT BRISTOL

BLUNDELL, Spence and Co. Ltd., have built a new cellulose store at their depot at 80, Feeder Road, Bristol, 2, as part of a plan to extend and improve their service to industrial and transport paint customers in south-west England and South Wales. The new store is licensed to hold 1,250 gallons and will be mainly used for stocks of one of the company's leading transport finishes, Vulflo Self Gloss Automobile Finish. In addition the Bristol depot stocks up to 2,000 gallons of industrial and transport finishes.

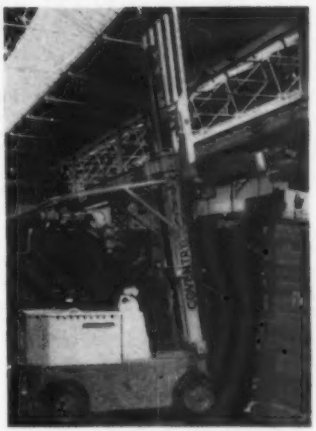
FORK-LIFT TRUCKS AVAILABLE ON CONTRACT HIRE

GEORGE Cohen, Sons and Co. Limited, members of the George Cohen 600 Group, are to offer fork-lift trucks on contract hire terms for the first time in Britain. The contract covers all aspects of maintenance, relieving the hirer of the costs of providing his own service and repair facilities. It covers, too, the provision of "stand-in" trucks to take over in the event of breakdowns, thereby eliminating production hold-ups from this cause: existing trucks can be purchased and replaced progressively by the latest machines, thus the scheme can be entered into immediately without further capital expenditure. The most telling advantages are economic since capital which would otherwise be tied up in fork trucks is freed for more productive investment; and the full amount of the payments under the contract is allowable as a business charge for income tax purposes.

The new scheme has been prepared by George Cohen's in collaboration with one of the country's leading producers of fork-lift trucks, Coventry Climax Engines Ltd. Coventry Climax trucks are already very widely used in this country and the range available meets most of the requirements of every industry; George Cohen's as pioneers of plant hire in many fields, have for a number of years offered fork-lift trucks on daily, weekly or monthly hire. The step forward from short term hire to a full contract hire scheme is thus the logical expansion of an already well developed service.

Further information may be obtained from George Cohen, Sons & Co. Ltd., Wood Lane, W.12.

The photograph shows a Coventry Climax type IGE battery electric truck, typical of the range available on contract hire. It has a capacity of 4,000 lb. at 24 in. centres and a lift height of 12 ft.



GRIFFIN AND GEORGE INSTITUTE LONG-SERVICE AWARDS

THE directors of the Griffin and George group of companies, Ealing Road, Alperton, Middlesex, have initiated a series of awards for the recognition of long service with the companies of the group. This is being done for the first time in its 136 years of existence. The first presentations were made at the Waldorf Hotel, London, on Friday, November 25, by Mrs. K. G. Sinclair, wife of the chairman of the Griffin and George Group, who was introduced by Mr. H. C. Mayer, financial director and secretary of the group.

The new scheme of long service awards provides recurring and increasing financial benefits for employees who have completed between 5 and 25 years of service. Thereafter, and in addition, presentations of gifts are made to those who have achieved, 25, 40 or 50 years of service.

At the company's dinner on November 25, the place of honour was taken by Mr. R. A. Pritchard, who has been with the group for 52 years. Seventeen members with between 40 and 49 years of service each received a gold watch. Another 50 received Parker pen and pencil sets, to celebrate their service of between 25 to 29 years.

In future years, there will be smaller numbers of recipients, since this initial presentation covers all the staff possessing the necessary qualifications.

REDUCTIONS IN PRICE OF ANHYDROUS BORAX

BORAX Consolidated Ltd. of Borax House, Carlisle Place, London, S.W.1, advise that since anhydrous borax has been freed of import duty, although duty has been paid on current stocks the scheduled prices for "Dehybor" have been reduced with immediate effect by £10 10s. 0d. per ton, to £58 10s. 0d. in paper bags and £59 10s. 0d. in hessian sacks net per ton, carriage paid in Great Britain; there is no change in the prices of other grades of borax (Decahydrate and Pentahydrate) nor in the price of boric acid. Borax Ltd. also draw attention to the fact that they are under notice of a substantial ocean freight increase affecting all their products and it may be necessary to make further adjustments between now and the spring of 1961.

KESTNER EVAPORATORS FOR TINNING PLANT

THE Kestner Evaporator and Engineering Co. Ltd., London, have recently received an order for two evaporators for concentrating an acid electrolyte liquor. These evaporators will form part of a complete installation, for the continuous production of tinned steel strip, ordered from and engineered by The Head Wrightson Machine Co. Ltd., of Middlesbrough who, hitherto, have used evaporators of American design for this application. The evaporators are of the single effect climbing film type, working under vacuum and are of Monel metal construction. The plant will be installed at the Ebbw Vale Works of Richard Thomas and Baldwins Ltd., and is due for starting up in the coming year.

OBITUARY

Norris. George Kent Ltd. deeply regret to announce that their deputy chairman, Mr. T. P. W. Norris, M.B.E., M.C., died as a result of a motoring accident on November 21, 1960. Mr. Norris, who lived at Redbourn, Hertfordshire, was 68 years of age; he was born at Reading and educated at Rugby and New College, Oxford. Prior to joining the Kent Board in September 1958, he was chief personnel officer of the Vickers group and before that labour manager of the Billingham division of Imperial Chemical Industries Ltd. He was also president of the Institute of Personnel Management.

* * *

Scholes. Smiths Industrial Division announce with deep regret the death, on Thursday, November 16th, of Mr. V. P. Scholes, one of their Birmingham area representatives.

Mr. Scholes, who was 42 years of age, was appointed in 1958 and was responsible for promoting the sales of Kelvin Hughes products.

He leaves a widow and 4 children

MEETINGS OF THE MONTH

January 3
Institute of Metal Finishing (Midland Branch). "Solution Conservation and Effluent Treatment for the Small Plater," by J. Lakin, at the James Watt Memorial Institute, Great Charles Street, Birmingham. 3. 6.30 p.m.

January 4
Society of Chemical Industry (London Branch). Discussion on Galvanic Anodes by G. E. Gardam, P. V. Palmer and K. P. Scott at 14 Belgrave Square, London, S.W.1. 6.0 p.m.

January 11
Institute of Metals (Manchester Metallurgical Society). "Modern Methods of Metallurgical Analysis," by K. M. Bills, at the Manchester Literary and Philosophical Society, George Street, Manchester. 6.30 p.m.

Institute of Metal Finishing (Organic Finishing Group). "Polyurethane Finishes and Foams," by H. J. Shearing, at the British Institute of Management, Management House, 80 Fetter Lane, London, E.C.4. 6.30 p.m.

January 14
Institute of Metal Finishing (London Branch). Dinner and Dance at the Cafe Royal, Regent Street, London, W.1. 6.30 p.m. for 7.0 p.m. Tickets (37/6d.) from the secretary, Mr. S. W. Baier, 9e Cleveland Road, London, W.13.

January 16
Institute of Metal Finishing (London Branch). "Chromate Conversion Coatings on Aluminium," by W. Marchand, at the Northampton College of Technology, St. John Street, London, E.C.1. 6.15 p.m.

Institute of Metal Finishing (North-West Branch). "Hard Chrome Plating," by J. Corfe, at the Ogden Arms Hotel, Sackville Street, Manchester. 7.30 p.m.

January 17
Institute of Metals (South Wales Local Section). "Metals and Alloys Used in the Jewellery and Silverware Industry," by Miss D. L. Pile, A.I.M., at the Royal Institution, Swansea, 7.0 p.m.

January 18
Society of Chemical Industry (London Branch). "Metallic Diffusion Coatings," by R. L. Samuel at 14, Belgrave Square, London, S.W.1. 6.0 p.m.

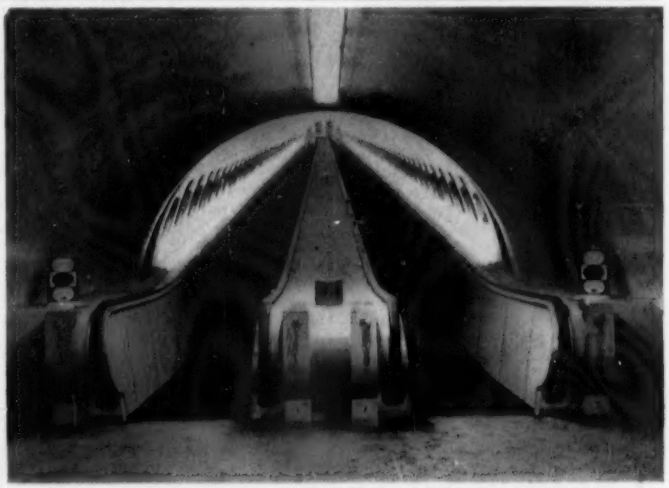
January 18
Institute of Metal Finishing (South-West Branch). "Methods of Preparation for Plating" (c) Chemical and Electrochemical, by D. Sinclair, at the Assize Courts Hotel, Bristol. 7.30 p.m.

January 19
Institute of Metals (Birmingham Local Section). "Heat-Treatment of Metal Components," by E. Mitchell, A.C.T. (Birm.), F.I.M., at the College of Technology, Gosta Green, Birmingham. 6.30 p.m.

January 19
Institute of Metals (North-East Metallurgical Society). "The Effects of Nuclear Radiation on Metals," by H. M. Finniston, B.Sc., Ph.D., A.R.T.C., F.I.M., at the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough. 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY CONVERSAZIONE

THE Corrosion Group of the Society of Chemical Industry will hold for the first time a conversazione at the Society's headquarters at 14, Belgrave Square, London, S.W.1, during the evening of Thursday, January 26, 1961, when an exhibition will be held as an added attraction. Offers are now invited of exhibits illustrating new developments in corrosion prevention and protection and exhibits describing current research and fundamental progress. Intending exhibitors are asked to give preliminary notice as soon as possible to Dr. E. C. Potter, Central Electricity Generating Board, Grove Road Power Station, Lodge Road, London, N.W.8. Facilities available will be 230 volts a.c. trestle tables, but no water or gas.



BANK TRAVOLATOR LINED WITH PVC-COATED STEEL

THE Bank "Travolator," which connects the Bank Station with the Waterloo and City Line, is lined with "Stelvetite" plastic-coated steel manufactured by John Summers and Sons Ltd. at Shotton, Chester. The Stelvetite is blue-brown in colour with an attractive "tweed" embossing, which, with the brilliant illumination throughout, gives an appearance of warmth and modernity; 282 sheets measuring 12 ft. by 2 ft., curved to the tunnel's shape and totalling 8,000 sq. ft. were used. The Travolator is 312 ft. long and consists of two moving platforms which run at a speed of 180 ft. per min. up and down an incline of 8½ degrees; the semi-circular tunnel is 24 feet round (i.e. half circumference), 16 ft. 6 in. wide at deck level and 10 ft. 6 in. high at the crown. The Stelvetite is fixed to the tunnel by means of rolled sheet-steel sections, consisting of vertical box-channel ribbing, spaced 2 ft. 1 in. apart; the balustrading and decking panels on each side of the travel strips consist of "Armourply" metal-faced plywood, manufactured by William Mallinson and Sons Ltd., incorporating "Galvatite" hot-dipped galvanized sheet steel on the reverse side, produced by John Summers and Sons, who have also supplied electrolytically galvanized sheet steel used on the skirting panels.

Trade and Technical Publications

Stillite Products Ltd., 15 Whitehall, London, S.W.1., have produced technical leaflets giving details of the use of Therbloc mineral wool slabs for furnace and stove insulation. This material is claimed to have outstanding thermal properties when compared with conventional types of insulating brick such as diatomite and vermiculite, and also has a marked effect in reducing noise.

* * *

A comprehensive catalogue dealing with metal baskets has been published by the metal finishing firm, Tool Treatments (Chemicals) Ltd., Colliery Road, Birmingham Road, West Bromwich. The range covers all types of round and oblong baskets in mild steel, expanded mild steel, stainless steel, mild steel perforated and plastic-coated steel. Of particular interest is the metal transporter model for phosphate treatment in conjunction with automatic overhead tracks.

* * *

Translation and Technical Information Services of 32 Manaton Road, London, S.E.15 have published a bibliography "Aerosol Paints and Lacquers" which includes brief historical notes, description of the aerosol valve and can, propellant, formulation of paints and lacquers, loading, and some six pages of references to literature in which the subject of the use of aerosols can be explored. The booklet is obtainable from Translation and Technical Services, price 5s. or $1.

* * *

A record issue of the Wild Barfield Heat Treatment Journal contains an eight page article on "Jigs and Fixtures for heat-treatment and other metallurgical operations," by L. G. W. Palethorpe, chief metallurgist of Wild-Barfield Electric Furances Ltd., an article on "Electric Batch Furnace for Heat-treating Titanium" and a shaker hearth furnace installation for heat-treating bearing components. This monthly bulletin can be obtained from Wild-Barfield Electric Furnaces Ltd., Otterspool Way, Watford by Pass, Watford, Herts.

* * *

The Hanson-Van Winkle-Munning Co., Church Street, Matawan, N.J., U.S.A., have issued in a colour folder, Bulletin No. P.PB-111, nine new plating barrel and accessory equipment bulletins describing the following equipment produced by H-VW-M; mercil-type portable barrels, special barrel equipment, mercil-type hanger equipment, hanger mounted motor drive equipment, cylinder materials and construction, plating barrel contacts, tank and drive equipment and tank transfer equipment; a final bulletin gives complete specifications for all standard model barrel units and all mercil-type MH barrel units.

* * *

"The Effect of Weather Conditions on the Gloss Retention of an Alkyd Paint pigmented with Rutile Titanium Dioxide" by E. Oakley, is the title of a booklet issued by the British Titan Products Co. Ltd., 10 Stratton Street, London, W.1, and represents a reprint of an article which appeared in the Journal of the Oil and Colour Chemists' Association, March 3, 1960. The booklet describes and analyses the results of examination and tests of a large number of alkyd gloss paints of identical composition which have been exposed to natural weathering conditions at different times of the year. The results show that the degree of gloss failure has been shown to be closely related to the amount of solar energy falling upon the panel surface, total energy greater than a fixed threshold value being most closely related to the rate of deterioration.

* * *

The Kestner Evaporator and Engineering Co. Ltd., 5, Grosvenor Gardens, London, S.W.1, has produced a 16-page folder-plate brochure dealing with the plant that they have installed for the Motherwell Bridge and Engineering Co. Ltd., at Motherwell, Scotland, to pickle the plate that is being produced there. The plant consists of hot sulphuric acid pickle, hot wash, hot phosphating and a special section of the plant to give a paint protective finish.

Also available on request from Kestner is a fully illustrated loose-leaf brochure, divided into fourteen sections which describe the nature of the Kestner climbing film evaporator and the ancillary plant such as heat exchangers, coolers, condensers and vacuum raising equipment. There are tables giving pertinent hydrometer scales and the properties of saturated steam.

ELLIOTT BROS. TO SELL AMERICAN AIRBRASIVE TOOL

ELLIOTT Brothers (London) Ltd. of Lewisham, London, S.E.13, one of twelve companies comprising Elliott-Automation Ltd.), has been appointed exclusive representatives in the British Isles for promotion and sales of the "Airbrasive" unit for cutting and abrading of hard, brittle materials. The tool, a product of S. S. White Industrial Division, New York City, is available at Elliott Brothers' offices for demonstration purposes. The unit cuts or abrades almost any hard, brittle material—such as germanium, silicon, ferrite, glass, and others—with its precisely controlled stream of gas-propelled abrasive. Emerging from the cutting tip nozzle at 1100 ft. per second, the small particles produce a cool, shockless cutting action. Material removal is extremely accurate, and cuts as fine as 0.008 in. can be made.

Airbrasive has many applications in other industries, such as metals (cutting, deburring, and surface preparation), chemicals, ceramics (including glass), and in general laboratory and research activities.

Abrasive material ordinarily used is aluminium oxide in the 27 micron range. For certain applications lighter abrasive is available. Any compressed gas source of 80 ib. per sq. in. can be used, if it is dry. Cutting speed can be varied accurately by controlling the abrasive flow or the cutting tip distance.

The tool and the work do not make contact, and what little heat is produced is immediately dissipated by the propellant gas.

Two models are manufactured—Model C, a single jet unit for low-volume production and experimental work, and Model D, a twin-jet unit with double the capacity of Model C and even greater versatility.

CHANGE OF NAME

THE Electric Resistance Furnace Co. Ltd., a member of the EFCO group of companies, has changed its name to EFCO Furnaces Ltd. as from December 1. The change has been considered desirable due to the increased scope of the company's interests which were originally confined to electric resistance heating but have in recent years been widened to include both gas and oil-fired furnaces.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Surface Treatment of Aluminium

THE Metal Finishing Division of the Pyrene Co. Ltd., Great West Road, Brentford, Middlesex, have introduced a new range of treatments for aluminium and aluminium alloys comprising Bonderite 710, Bonderite 701, Bonderite 740, and Aluma Etch 391, a controlled alkaline etchant. The techniques employed represent an extremely low temperature method of coating aluminium and convert the aluminium surface into a thin amorhous oxide-chromate coating which is integral with the metal itself. Bonderite 710 coatings give a well-defined golden colour and can be used with equal efficiency with small aluminium parts and continuous strip, giving fast and economic results ; the amorphous coating tightly bonds paint so that complex forming operations can be performed without impairing paint surface. Bonderite 701 results into an amorphous oxide-chromate coating of a pleasant green colour which is integral with the metal and is light-fast. The coating, in its own right, offers excellent corrosion protection to aluminium and aluminium alloys and has many architectural applications where durability and colour count. Bonderite 740 is another oxide-chromate treatment providing a coating which is both an ideal base for organic finishes and a corrosion resistant film in its own right. It can be applied by immersion, spray or in a continuous strip line and has been specially developed for treating aluminium and aluminium alloys in mixed production with steel.

Aluma Etch 391 is a scale free, controlled alkaline aluminium etchant for uniformly etching the surface of aluminium in an immersion bath and unlike other etching solutions where dissolved aluminium reacts with caustic soda to form insoluble sodium aluminate, the special formulation of Aluma Etch prevents the conversion of sodium aluminate into sludge and does not produce suspension or precipitate.

Surface Finish Measurement

FIG. 1 shows a portable surface measuring instrument manufactured by Payne Products International Ltd. of Buckingham Avenue, Slough, Bucks. The instrument is an improvement on the previous model which was fitted with a meter showing centre line average readings and a graduated scale and selector knob used for the determination of maximum scratch depth from the mean centre line—the new version of the instrument provides a meter reading which by push-button selection indicates one of the following values; Ra (centre line average), Rp (maximum height of profile from mean centre line), Rmax (maximum depth of scratches) peak to valley.

The instrument covers the range 0.300 micro-inches with three available " cut-off " lengths (waviness limited) as follows; 0.003 in., 0.010 in. and 0.030 in. Various types of tracer heads are available for measuring flat surfaces, spherical surfaces, bores, tooth flanks, ball races etc. The standard instrument is fitted with a stylus head of 4 mm. stroke length and a special model is obtainable providing three alternative stroke lengths between 1-2 mm. A pen recorder is also available for providing permanent records of surfaces.

(*Continued in page* 504)

Fig. 1—*Surface finish tester*

I'm afraid it's all silver

No call to apologise! Indeed the best conductors *are* silver . . . and the brighter the better. The new PLUSBRITE Silver addition agents provide the fastest silver plating process and the brightest finish for electrical contacts. With PLUSBRITE Silver the deposit of metal is unalloyed and retains its full electrical conductivity. PLUSBRITE Silver addition agents assist in forming an exceptionally hard deposit of bright silver, which notably resists tarnish. They are finding use also in a wide range of silver-plated products. Mechanical finishing can often be eliminated.

Plusbrite

ADDITION AGENTS

For technical information or service ring or write to:
ALBRIGHT & WILSON (MFG) LTD
METAL FINISHING DEPARTMENT
1 KNIGHTSBRIDGE GREEN
LONDON · SW1
Telephone: Kensington 3422

TBW 704

Adhesive Coated Aluminium Foil

THE Rubber and Asbestos Corporation of Bloomfield, New Jersey, U.S.A., for whom the agents in this country are Omni Ltd., 35, Dover Street, London, W.1., have produced an adhesive-coated aluminium foil, Plymaster ACA-1050 for sandwich panels and other metal-to-metal bonding used in lightweight, non-loading construction such as is encountered in the aircraft industry. The material is claimed to have excellent peel strength and filleting properties and is easy to handle ; it is available in roll form in widths of up to approximately 48 in. and lengths up to approximately 400 ft. Currently available material consists of 5052 full hard aluminium alloy in nominal foil thickness of 4 mils or 8 mils, coated to an adhesive weight of 0.028 ± 0.002 lb. per sq. ft. and is shipped with a green-coloured polyethylene interliner to prevent blocking in transit and storage.

After application the foil is cured at a temperature of 350°F. for 30 minutes at a pressure of 10-25 lb. Tests have accredited it with a peel strength by the torque wrench method of well over 40 in. lb. per 3 in. width ; tensile shear strength tests conducted on Plymaster bonded to plywood have resulted in a rupture of the plywood at 640 lb. per sq. in. with the bond between the Plymaster and the wood unaffected ; shear strength at elevated temperatures appears to be excellent at 180°F., a modest fall-off to 240°F. and a sharp fall-off above that temperature.

Cold Airless Spray Equipment

FIG. 4 shows the Graco Model 226-066 Stationary Hydra-Spray which is being distributed in this country under the sole agency of Alfred Bullows and Sons Ltd., Long Street, Walsall. The spray operates direct from open-top shipping drums which are skid mounted for ease of movement ; special drums are not necessary at the hydrostatic pressures are confined to the pump, 20-ft. Teflon tubing and the spray gun. High operating pressures are achieved by a reciprocating double-action air motor, coupled by a connecting rod to a reciprocating double-acting pump which multiplies the fluid pressure to twenty times the air pressure admitted to the air motor ; thus, an incoming air-line pressure of 90 lb. per sq. in. is developed by the pump to 1800 lb. per sq. in. When released at this high pressure through the small orifice of the nozzle, paint is very finely atomized and travels at very high speed to the work target, Since compressed air is not used to atomize the paint, there is no rebound of air from the sprayed surface and consequently no bounce or overspray. This method of application is faster and gives a better finish and provides a paint saving of approximately three gallons out of every ten gallons sprayed by conventional methods. The pump, together with an air-operated paint agitator, air inlet pressure reducing valve, etc., is mounted on the drum head assembly, which, when in position, is held rigidly by two cover hold down rods and fits snugly over the paint drum, thus ensuring the exclusion of dirt from the paint. Changing paint drums is facilitated by the provision of an air-operated elevator, which raises and lowers the complete drum head assembly.

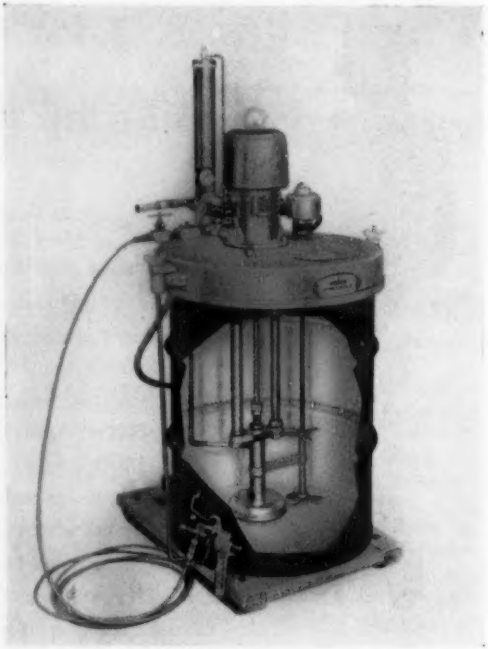


Fig. 4—Airless spray equipment

Sulphur-Free Semi-Bright Nickel

A SULPHUR-FREE semi-bright nickel process, Permalume, developed in 1958 by the Hanson-Van Winkle-Munning Co. of Church Street, Matawan, New Jersey, U.S.A., has been in full operation since February 1960 after more than a year of pilot plant trials. The process can be continuously purified by carbon treatment without the loss of addition agents and has a high throwing power, which enables maximum grain refinement to be obtained in recessed areas such as are frequent in die castings and stampings of complex shapes. The Permalume deposit is said to be highly receptive to subsequent deposits and when used as an undercoating with a full-bright top coating produces a duplex deposit with a very high resistance to corrosion.

(*Continued on Advert page* 25)

Liquid Coloured Plastic

A LIQUID coloured plastic, Polyurethane 708, for yachts and small craft, but which can be used on metals in other applications, has been developed by International Paints Ltd. of Grosvenor Gardens House, London, S.W.1, and will be introduced at the Boat Show at Earls Court, January 4 to 14. The main features are that it can be used for interior or exterior use above or below water, has excellent durability even after prolonged exposure, has superfine gloss and gloss retention properties, exceptional resistance to abrasion, is unmarked by spillage of fuels, oils, paraffin, battery acid, wines, spirits, milk and fruit juices, is unaffected by boiling water, hot fats or pans and can be cleaned with strong detergents or domestic abrasives without deterioration of the surface. The coating consists of a base and hardener which are mixed immediately before use, and can be applied by brush, roller or spray down to temperatures of 40-45°F. The polyurethane dries in about 2/3 hours but should not be overcoated in less than 6 hours. A further 7 days at a minimum temperature of 45°F. are required to fully cure and complete the chemical reaction between the two components.

Liquid Industrial and Marine Detergent

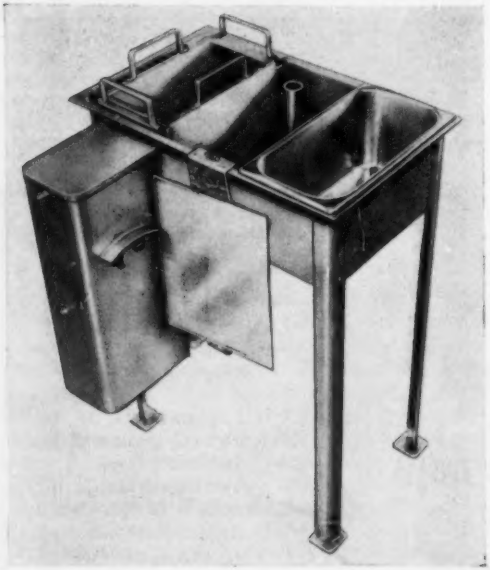
DASCO Klean, a liquid detergent cleaner, manufactured in this country by D. A. Stuart Oil Co. (G.B.) Ltd., 11a, Albemarle Street, W.1 (a subsidiary of the Amber group of companies) is claimed to remove grease and dirt of any consistency from all types of machines and hard surfaces and can be used in either hot or cold fresh water or sea water. No stirring is required and while it is strong enough to deal with the heaviest type of industrial cleaning, it will not remove paint or harm the skin ; it can be applied by means of a rag or a spray gun. There are four types—No. 403, an all-purpose industrial cleaner for machines, ceilings, floors and other plant ; No. 407, a combined machine tool cleaner-germicide, primarily intended for use as a machine tool coolant sump cleaner ; No. 415, a marine cleaner which readily emulsifies with sea water without heating, cleans tanks in cargo ships and tankers, removes heavy grease deposits, and when sprayed on the sea surface removes oil pollution ; No. 416, for degreasing, does not require hot water and can be applied with a spray gun in order to reach inaccessible parts.

(*Continued in advert page* 26)

Metal Parts Chemical Cleaner

FIG. 2 illustrates the "Metal Parts Cleaner" manufactured by the Pall Corporation, Glen Cove, New York, which is effective on parts of simple configuration and is equally suitable for parts of unusual or convoluted shapes such as the inside of tubes and small holes in complex shapes; it is claimed to be superior in cleaning ability to other systems including most commonly used ultrasonic equipment. Cleaning is performed with "Pall Clean" solutions which contain effective chemicals and detergents. Stainless steel, brass, aluminium, carbon steel, nickel and nickel alloys, and other materials can be finished to a bright surface and the cleaner will remove encrusted carbon, weld oxides, brazing flux, varnish and paint. The cleaner has no moving parts or electronic tubes and maintenance is low; operation requires little or no special training of operators.

Fig. 2—Chemical cleaner



Air Nozzles for Use with High-Speed Spray Guns

ALFRED Bullows and Sons Ltd., Long Street, Walsall, have produced four new air nozzles for use with their L.540 lightweight automatic spray gun and the L.1900 lightweight hand operated spray gun, both of which have air and material nozzles which are interchangeable and can therefore be used on either gun. Three of the new nozzles are in the Bullows Group 1. The 63 PH 2 was developed in conjunction with the Binks Manufacturing Co. of Chicago to meet the need for a nozzle suitable for acrylic resins. 66 PD is a tangential nozzle in which the air ports are arranged so that air passes tangentially across the face of the nozzle, thereby using the full kinetic energy of the discharged air and providing a very wide spray and maximum coverage of the gun with minimum consumption of air at minimum pressure. 66 SD is designed for use with the suction set-up and using lower air pressures, and is claimed to give a higher performance with finer atomization than has been previously possible with other suction feed set-ups. The fourth nozzle, 68 M, is a mistless nozzle for low pressure spraying, where, for instance, exhaust facilities are inadequate and cover spray must be reduced to a minimum.

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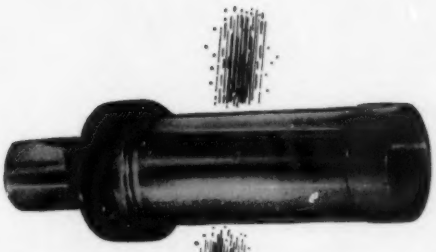

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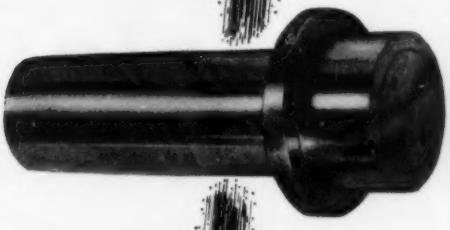

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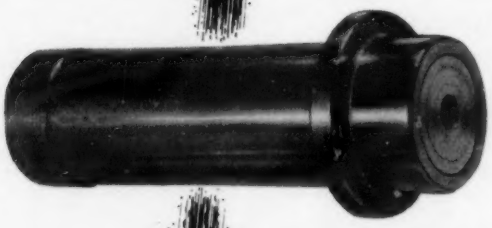

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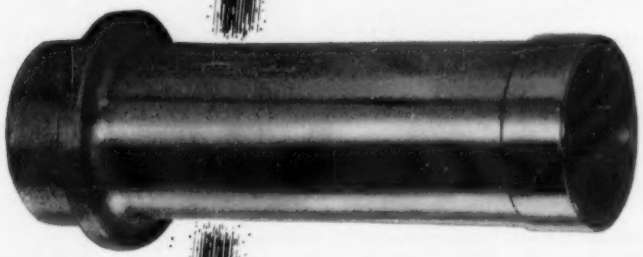

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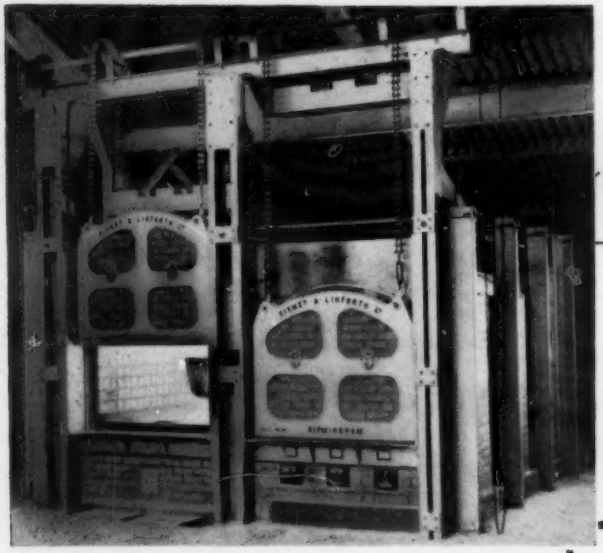

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